Ambix

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THE GNOMON

as a possible link between (*a*) one type of Mesopotamian *Ziggurat* and (*b*) the Magic Square Numbers on which Jabirian Alchemy was based.

By H. E. Stapleton[1]

Save, possibly, in the case of mathematicians, human thought is very largely controlled by environment; and it was perhaps due to the fact that a previous paper[2] had to be finished in the unfamiliar surroundings of a nursing home that the writer failed to observe (or mention) one noteworthy consequence from the historical point of view of establishing the identity between the basic structure of certain Magic Squares (with which the paper was largely concerned) and that of the Mesopotamian *Ziggurat* at Borsippa which was reconstructed under the order of Nebuchadrezzar in the first quarter of the 6th century B.C. This omission will now be rectified.

[1] The following pages represent the introductory section of a paper on Pythagoreanism that was read at the VIIth International Congress of the History of the Sciences, held at Jerusalem in August 1953.

[2] "Probable sources of the Numbers on which Jabirian Alchemy was based." (*Archives Internat. d'Histoire des Sciences*, Jan., Mar. 1953, No. 22, pp. 41–59.)

The original objective of the paper in question was to account for the curious series of numbers, 28, 17, 8, 5, 3 and 1 out of which the writers of the Jabirian alchemical *Corpus*[3] believed the Universe, and all it contained, to be built up.

Having noticed that the simplest 9-celled Magic Square figures more than once in the treatises of this *Corpus*, and realizing that the philosophy on which such a Number Theory was based was essentially Pythagorean in origin, it was decided to see what would be the result of subjecting this Square to dissection by a Pythagorean *Gnomon*, i.e. the numbered areas within thick lines as shown in Fig. 1. It then became obvious that the "alchemical" numbers in question were all to be found in this Magic Square. The total of the four numbers within the Gnomon is 28: the numbers in the remaining four cells of the Square are the actual series 8, 5, 3 and 1: while, finally, the total of this last series is 17. Thus, the whole series of "alchemical" numbers was intimately related to this—the First—Magic Square, and might, indeed, have originated from it.

A further method of analysing the "figure content" of the same Magic Square is to state this in terms of the Central number: and the resultant graph is that shown in Fig. 1(*a*).

If the same method of analysis of the numbers assigned to the constituent cells be successively applied to each of the higher Magic Squares with an odd number of cells, an extra "platform" will appear in each of the resultant graphs, until, finally, in the case of the Magic Square with 81 cells (Fig. 2), the resultant graph with its corresponding numerical (or area[4]) totals is that shown in Fig. 2(*a*).

Beginning with the first Magic Square—the formula of whose single "platform" is X (the central number) $\times 3^2$, the additional "platforms" of the subsequent Squares with an odd number of cells have totals respectively of $X \times 5^2$, $X \times 7^2$ and $X \times 9^2$. In other words, each total is a function of the total number of cells in the side of each Square.

The graph shown in Fig. 2(*a*) so closely resembled in plan the ordinary representation of a Mesopotamian *Ziggurat* that it was decided to look up the

[3] Compiled in Arabic about A.D. 900.

[4] In case any reader queries these references to areas, it may be recalled that in ancient China the ancestral square *Ming-Tang* temple had 9 rooms to which, in the same order, the numbers of the first Magic Square are assigned. Prof. H. H. Dubs of Oxford, when commenting on the previous paper, also noted that not only did the ancient Chinese place their Royal (later Imperial) Domain at the centre of a 9-squared division of the country, but the Chinese philosopher Dzou Yen (IVth cent. B.C.) enlarged this scheme by saying (*a*) that China was the south-eastern square in a 9-square continent, and (*b*) that the world was composed of 9 continents arranged on a 9-square basis. No numbers, however, appear then to have been connected with this arrangement.

From Fig. 2(*a*) it will also be evident that whatever the significance of the Central number may be, this variety of Magic Square can be represented by a ground plan that depends, not only on this central number, but also on the *square of the number of cells on any one side* of the individual square that is being considered.

4	9	2
3	5	7
8	1	6

Fig. 1. Magic Square assigned to Saturn and Lead.

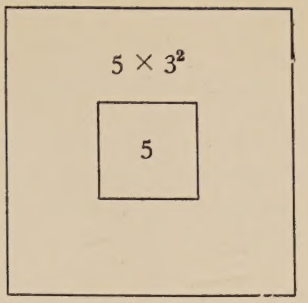


Fig. 1(*a*).

5	54	13	62	21	70	29	78	37
46	14	63	22	71	30	79	38	6
15	55	23	72	31	80	39	7	47
56	24	64	32	81	40	8	48	16
25	65	33	73	41	9	49	17	57
66	34	74	42	1	50	18	58	26
35	75	43	2	51	10	59	27	67
76	44	3	52	11	60	19	68	36
45	4	53	12	61	20	69	28	77

Fig. 2. Magic Square assigned to the Moon and Silver.

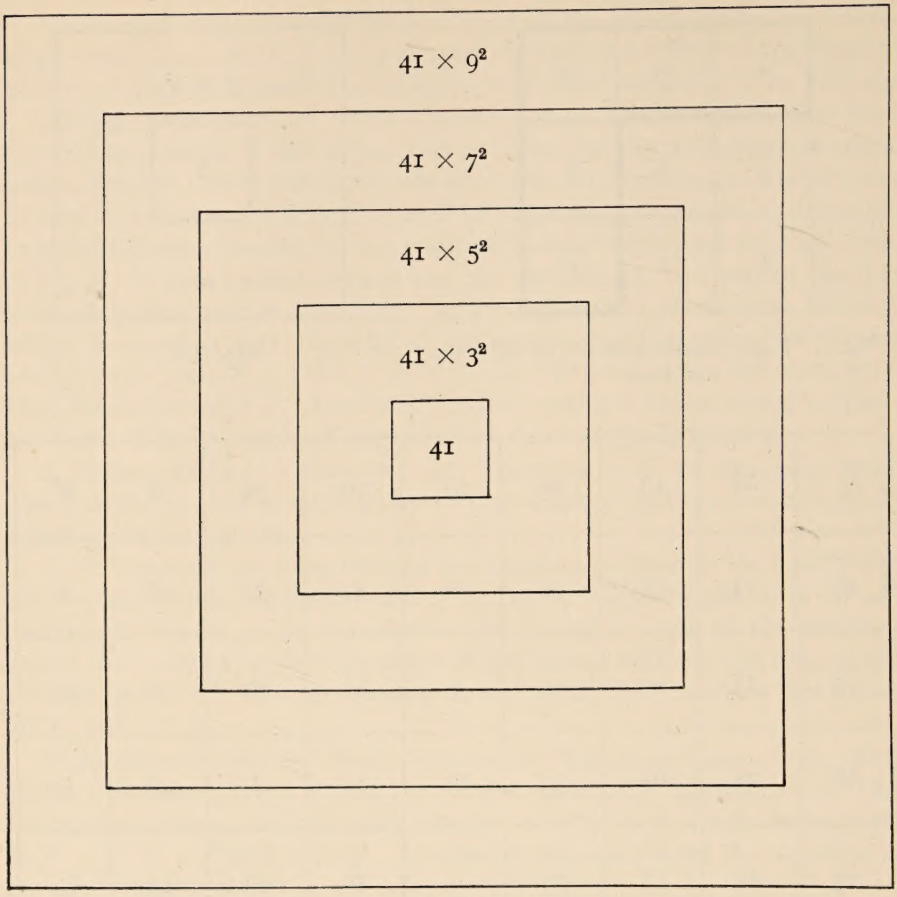


Fig. 2(*a*).

recorded measurements of these ancient buildings in order to ascertain whether any similar numerical relationship could be detected in the case of the platforms of a square *Ziggurat*. The one finally chosen was that excavated by Sir Henry Rawlinson about a century ago at Borsippa, N.W. of Babylon, and the measurement of the 4 surviving platforms that could be traced by him with any certainty were found to be as follows:—

D	Each side 146 feet
C	,, ,, 188 ,,
B	,, ,, 230 ,,
and A (the lowest platform)	,, ,, 272 ,,

Inspection of these figures quickly showed that they bore exactly the same relationship of odd numbers to one another as had already been found to exist

between the "platforms" of Magic Squares: but in this case real platforms were being studied and not hypothetical ones. The respective areas of the 4 platforms A B C D of the Borsippa *Ziggurat* are in the ratio of 13 : 11 : 9 : 7; and if Sir Henry was correct in believing that the ancient name of the *Ziggurat E-ur-imin-an-ki* (Temple of the Seven Rulers of the Heavens and the Earth) showed that this *Ziggurat* originally possessed 7 platforms—dedicated respectively to the then recognized seven Planets—and if the remaining 3 platforms could have been measured, their areas would almost certainly have been found to be in the continued descending ratio of odd numbers, viz.: 5, 3 and 1.

We are now therefore in a position for the first time to state what was the architectural rhythm of at least one type of Babylonian *Ziggurat*, viz.: that it consisted of superimposed cubes[5] (of sun-dried or burnt brick), the areas of any face of each cube being in proportion to the series of odd numbers 1, 3, 5, 7,

[5] Like the Chinese, the Babylonians believed that the world was square (*vide* references to its Four Quarters): and the suggested cubic structure of the Borsippa *Ziggurat* seems probable in view of the original cubic shape of the Ka'aba at Mecca, and of Solomon's Holy of Holies on Mount Moriah. As H. Lewy has shown in her 1950 paper (Hrozny *Festschrift*), both these temples began by being dedicated to Salim, the planet Saturn.

If, moreover, there happened to survive in the Greece of 460 B.C. any belief that these Temple Cubes represented either the Universe or the Earth, this may have played some part in the assignment by Plato of the form of a cube to the element Earth. That Harmony was believed by the Pythagoreans to be symbolized by the Cube is suggested by the story (quoted by Heath, *Manual of Greek Mathematics*, p. 51) that "Philolaus is said to have called the cube a 'geometrical harmony' because it has 12 edges, 8 angles and 6 faces, and 8 is, in harmonics, the mean between 12 and 6".

The origin of the Pythagorean belief that "Harmony is the Key of the World" can be gathered from what is noted by Nicomachus (the mathematician of Gerasa in Judaea who flourished *c.* A.D. 100) that the "special 'most perfect proportion' consisting of four terms and called 'musical'—was discovered by the Babylonians and first introduced into Greece by Pythagoras. The proportion (used by various early Pythagoreans and, finally, by Plato in his *Timaeus*) is—

$$a : \frac{a+b}{2} = \frac{2ab}{a+b} : b$$

a particular case being 12 : 9 = 8 : 6. The two middle terms are the arithmetic and harmonic means between the extremes" (Heath, *idem*, p. 52).

If we consider the wealth of musical instruments that were in use in ancient Sumeria and the discussion by Woolley (on pp. 257–8 of Vol. II—Royal Cemetery Texts— of his *Ur Excavations*) of the possible ultimate derivation of Music from a study of the various sounds emitted by certain familiar animals, such as the bull, the cow, the calf and the stag, it is difficult not to agree with Woolley that there is a 'considerable possibility that the Sumerian musicians possessed a knowledge of harmony very surprising at so early a date (2700 B.C.)'. May not the Greek modes have a parallel if not a precedent in Sumer?"

Woolley may, indeed, have been too cautious in the last-quoted sentence: for there can now be little doubt that Pythagoras' ideas on Harmony and its connected theory of Mathematics—from which (through his greatest disciple Plato) all our present knowledge of the Universe stems—were ultimately derived from Mesopotamia.

9, 11 and 13. For stability of the resulting tower, these masonry cubes were sunk into one another: and as A. Parrot has shown in the last chapter of his recent book (*Ziggurats et Tour de Babel*), the main object of the tower was to provide a means whereby the local deity could descend from Heaven at times of festivals to receive, in the temple at the base of the tower, the offerings of the assembled worshippers. Stairways were often provided between the different platforms (or even, as at Ur and elsewhere, there was a ramp from the ground level up to the 1st or 2nd platform). In other cases, the path to the summit of the *Ziggurat* may have run spirally round the tower from platform to platform.

Two possible explanations may be offered of why the platform areas were constructed in the ratio of odd numbers.

The first arises from the fact (that must have been noticed in early Babylonia) that if any series of consecutive odd numbers beginning with 1 are added, the result is a square number. This would suggest the association in a *Ziggurat* of square areas with odd numbers.

Secondly, the sum of the series of odd numbers 1, 3, 5 . . . 13 is 49, which is the *Square* of the sacred number 7. If, moreover, the *Ziggurat* had actually 7 platforms, the sum of the numbers 1, 2, 3 . . . 7 is 28, which happens to be both 4 times 7, and also the second Perfect Number.

In the Borsippa *Ziggurat* the front of each square platform was set back 30 ft. from the front of the one below it (*vide* the copy of Rawlinson's Elevation that is to be found on p. 61 of Parrot's book), but, apart from this, the ground plan follows mathematically the model of Fig. 2 (*a*) *supra*. The only need is to substitute 1 for 41 in the top (central) platform, and increase the number of platforms from 5 to 7. The areas of the remaining 6 (below the top one) will then be 1×3^2, 1×5^2, 1×7^2, 1×9^2, 1×11^2 and finally, for the ground platform, 1×13^2.

What I did not think of doing before completing the previous paper was to draw a quadrant plan of the *Ziggurat* in the mathematical (i.e. *Gnomonic*) form adopted by Pythagoras, the Greek philosopher (of *c.* 572–500 B.C.), and his followers. If I had done so, I would then have been forced to consider the historical implications of Fig. 3.

It is not known when exactly Nebuchadrezzar (604–561 B.C.) carried out the reconstruction of the Borsippa *Ziggurat*, but unless this was not done until the last few years of his reign (which is improbable), it is obvious that what Pythagoras and his followers called *Gnomonic* (or odd) numbers were being used as the fundamental architectural ground plan of this Babylonian *ziggurat* before Pythagoras was even born. Pythagoras would therefore appear to have derived his ideas on Gnomonic figures and numbers from previously existing Babylonian architectural practice and mathematical knowledge.

Corroboration of this deduction is to be found in the statement of the 5th century B.C. historian Herodotus (Book II, end of para. 109: G. Rawlinson's

translation) that "the Sundial, the *Gnomon*, and the division of the day into 12 parts were received by the Greeks from the Babylonians": and it is quite easy to understand how the idea of the *Gnomon* arose in Mesopotamia. The floors of the temples (and, later, of palaces and even the better class houses) were paved with square tiles: and a people who—as we now know from the pioneering work of Neugebauer, Sachs and Bruins on cuneiform mathematical tablets—were the first to study mathematics from the purely theoretical point of view, could not have failed to notice that in every square group of 4 tiles, one tile

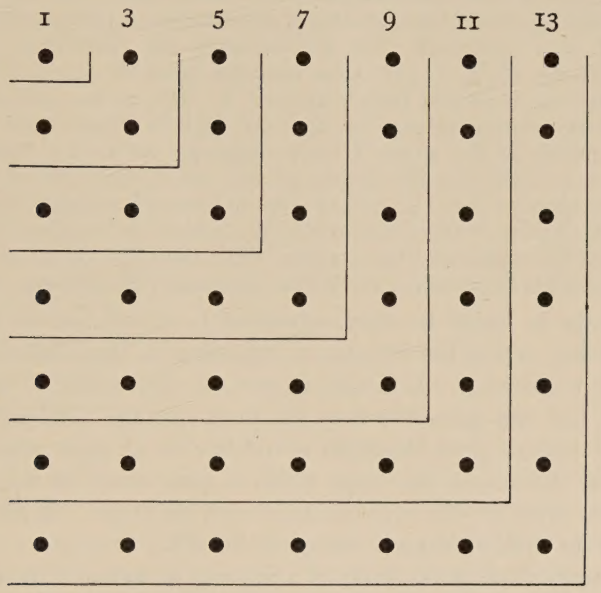


Fig. 3.

was partially enclosed by the other 3: in every square group of 9 the former square of 4 was partially enclosed by the remaining 5, and so on. The resultant rectangular figure, resembling in shape a Carpenter's Square, was given in Greek the name *Gnomon*. Similarly, the odd totals 3, 5, etc. of the tiles needed to complete these new square groups—with the addition of the unit number—were called the *Gnomonic* Numbers. Other meanings assigned to this word *Gnomon* in Liddell and Scott's lexicon are Judge or Interpreter: Guardian or Inspector of the sacred Olive at Athens: and the Index of the Sundial. Finally, according to Heath (*Manual*, p. 45), *Gnomon* connoted perpendicularity.

It is doubtful, however, whether sufficient consideration has been previously given to the real implications of this word. It is derived from the same root as the Greek *gignoskein* to know: but what *knowledge* was it supposed to impart? Would the upright stick whose shadow marked on the surface of the sundial

the passing hours have been assigned a name that almost suggests that the stick —with the aid of the sun's rays—had been changed into Ea—the third of the Babylonian Supreme Triad, Master of Wisdom and of the knowledge of the Magic Name[6]—or into Hermes, the imparter to the Greeks of the knowledge of Time?

That the original form of the sundial *Gnomon* was *not a straight rod* but a succession of *steps* will be evident from the following quotation from Note A, p. 498, Chapter XXII, of Layard's *Nineveh and Babylon*:—

> "Since writing the above [viz.: that the brickwork still visible in the lower part of the Birs Nimroud mound as well as in the upper, shows the sides of several distinct stages or terraces], I have found in a treatise by M. von Gumpach (*Die Zeitrechnung der Babylonier und Assyrer*, Heidelberg, 1852, p. 25), some remarks upon the sundial mentioned in 2 Kings xx. 8–11 and Isaiah xxxviii. 8. The author conjectures that it may have been presented to Ahaz by Tiglath Pileser, and he restores it very nearly in the shape I have suggested as having been that of the edifices of which the Birs Nimroud and other great ruins in Mesopotamia are the remains, viz.: a series of steps or terraces, on which an upright pole cast its shadow. He observes that the hours were marked by the coincidence of the shadow of the *gnomon* with the edge of the steps (degrees). (See also his *Dissertation on the Old Testament*, Heidelberg, 1852, p. 181.)"

The passage in Isaiah to which attention is drawn runs as follows in the Revised Version, where the Prophet is repeating to Hezekiah the message of God that, in response to the King's prayer, his life would be spared. "And this shall be the sign unto thee from the Lord that the Lord will do the thing that He hath spoken [that Hezekiah would live for 15 more years]. Behold I will cause the shadow on the steps which is gone down on the dial (Hebrew, *steps*) of Ahaz with the sun to return backward ten steps. So the sun returned ten steps on the dial, whereon it was gone down"[7].

The *Gnomon*—both as the index of a Sundial, as well as in its later form of a Carpenter's Square—would therefore appear to have been intended to symbolize a Babylonian *Ziggurat*. If so, what further inference would seem probable?

In view of the fact that the Gnomonic Numbers have been shown to represent the architectural rhythm of the Borsippa *Ziggurat*, it may, to begin with, be suggested that the *Gnomon* was originally intended as a *cryptic* representation

[6] *Cf.* J. Marquès-Rivière's *Amulettes, Talismans et Pantacles*, pp. 83 and 86, Payot, Paris, 1950.

[7] Hezekiah was the son of Ahaz, King of Judah, who had appealed to Tiglath Pileser IV of Assyria (745–727 B.C.) for help in 734 B.C. against Pekah of Israel and Rezin of Damascus. This led to Pekah being deposed and Damascus becoming an Assyrian province (see C. H. W. John's *Ancient Assyria*, p. 109). Ahaz was completely subservient to the Assyrian monarch. He removed silver and gold from the Temple in Jerusalem to present to Tiglath, and, in addition to making various changes in the Temple with the idea of pleasing his Assyrian overlord in case he happened to pay a return visit to Jerusalem, made Urijah, the High Priest, build in the Temple a pagan altar, modelled on one Ahaz had seen in Damascus (*vide* 2 Kings xvi. 8–18).

of such a *ziggurat*, whereby followers of Assyrian[8] or Babylonian religion, both in Mesopotamia and elsewhere, could still imagine what the building looked like and what were the simple mathematical elements in its structure.

A similar—but even more cogent—example of cryptic symbolism is the 25-lettered quasi-Magic Square of the late 2nd or 3rd century A.D. Christians that has been discussed by J. Carcopino in the August 1948 number (pp. 16–59) of *Museum Helveticum*—*vide* Fig. 4. No one but an initiated Christian could possibly imagine that the letters in this Square were capable of being mentally transposed into a reminder of the crucifixion of Christ, or of their being read as a double reminder of the first two words "Pater Noster" of the Lord's Prayer—*vide* Fig. 4(*a*).

R	O	T	A	S
O	P	E	R	A
T	E	N	E	T
A	R	E	P	O
S	A	T	O	R

Fig. 4.

A
P
A
T
E
R
A/P A T E R N O S T E R/O
O
S
T
E
R
O

Fig. 4(*a*).

Moreover, as, in both cases, the initial P was prefixed by A (for Alpha) and each of the final Rs of the *Noster* had a suffix O (for Omega), this double A—O (by their reference to the phrase in Chap. I, v. 8 of "The Revelation", "I am the Alpha and the Omega, which is, and which was, and which is to come")—would again recall to the Christian interpreters of the 25 letters of the Square, the name of Christ, their Redeemer.

In conclusion, one further inference as regards the possible continued history of the *Gnomon* seems worth mentioning. If the 7 platforms of these square *ziggurats* were intended to represent the spheres in which the 7 Assyrian and Babylonian planets moved, the *Gnomon* may also have been regarded as symbolizing that portion of the Universe by whose influence man has long supposed himself to be chiefly affected. If so, this might explain why the *Gnomon* is still found in symbolic use as one of the chief emblems of Free Masonry.

[8] The *ziggurat* on which Hezekiah's sundial was modelled must have been Assyrian—a prototype of the one at Khorsabad (Dur Sharrukin, near Nineveh), built by Sargon II (722–705 B.C.), the next Assyrian king but one to Tiglath Pileser IV. As the plan of Sargon's square *ziggurat* that is to be found in V. Place's *Ninive et l'Assyrie*, shows, its platform areas bore the same numerical relationship to one another as those of Nebuchadrezzar's much later *ziggurat* at Borsippa.

A LICENCE OF HENRY VI TO PRACTISE ALCHEMY

By D. Geoghegan

INTRODUCTORY

Although the practice of alchemy, in England, had been forbidden by the promulgation of a *Statute* of 1403–4 (5 Hen. 4)[1,2], many persons subsequently petitioned for *Letters Patent* to engage in alchemical operations; and licences (with a *non obstante* of this statute), were granted on several occasions up to the first part of the 16th century.

Mediæval legal documents pertaining to the history of alchemy in this country are rarely found extant in private ownership. A descriptive account will, therefore, be given of such a document,[3] formerly in the library of Ecton Hall, Northamptonshire. It comprises (*a*) a petition to Henry VI for the grant of a licence to practise alchemy; (*b*) a draft of the *Letters Patent* under application[4]; and (*c*) a short memorandum to the effect that on 31 May, at Shene (i.e. Richmond), the King gave the petition to be duly executed by the Lord Chancellor[5]. By the addition of this memorandum, the document became an immediate warrant for the Great Seal.

Twelve petitioners are mentioned[6], but only three of them—John Fauceby, John Kyrkeby, and John Rayny—were granted the licence: their names are inscribed on the lower right-hand corner of the document. (Plate I.) The

[1] *The Statutes of the Realm*, ed. A. Luders *et al.*, London, 1816, Vol. II, p. 144: "Item, It is ordained and stablished, That none from henceforth shall use to multiply Gold or Silver, nor use the Craft of Multiplication: And if any the same do, and be thereof attaint, that he incur the Pain of Felony in this Case".

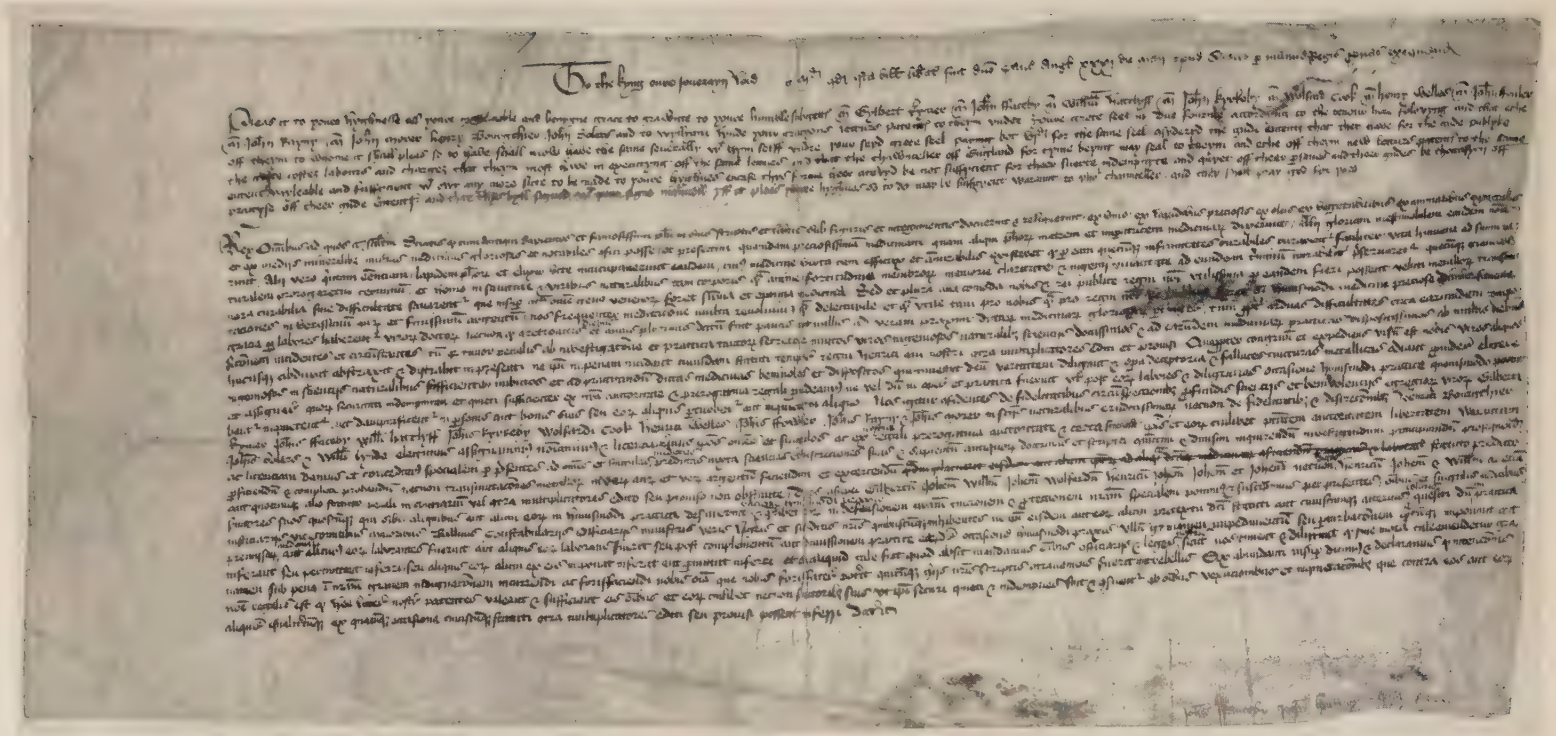
[2] The *Statute* of 5 Hen. 4 was not formally repealed until 1689 (*cf. Statutes at Large*, London, 1770, Vol. III, p. 436). It has been suggested that Boyle used his influence in this connexion (*cf.* Thomas Birch, *Life of the Hon. Robert Boyle*, London, 1744, p. 278). Sir Isaac Newton, in a letter to Locke of 2 August, 1692, declared his belief that it was for the sake of a recipe concerning a "process about the red earth and mercury" that Boyle procured the repeal of this statute (*cf.* F. S. Taylor, *Ambix* V (Oct., 1956), p. 59).

[3] MS. on vellum, in possession of the Museum of the History of Science, Oxford. (MS. Museum 84); approx. overall dimension 19.5 cm. (height) × 42 cm. (length). It is inscribed on the back (in an old hand) "Pat. 34.H.6. m [embrana] 7".

[4] Doubtless added as an *aide-memoire* to expedite the petitioners' case.

[5] Thomas Bourgchier, Archbishop of Canterbury.

[6] Gylbert Kymer, John Faceby, William Hatclyff, John Kyrkeby, Wolfard Cook, Henry Welles, John Fouler, John Rayny, John Morer, Henry Bourgchier, John Solers, and William Lynde.



MS. Museum 84 (reduced).

deed of licence for these three persons is enrolled in the *Patent Roll*[7] under date of 31 May, 34 Hen. VI (1456); and the text of the letters patent, cited in Rymer's *Foedera*[8], differs only in minor details from the original draft.

It has not been found possible to identify John Rayny, the last of the three named licence holders: but John Fauceby (or Faceby) is stated[9] to have been the king's physician, and that on 11 July, 1444, he received a grant of 100 l yearly for life. Anthony à Wood[10] refers to a "John Kirkby" who is described as "Principal of St. Frideswyde's Hall in St. Ebb's parish" (1436); and Macray[11], quotes from the *Register of Convocation* as follows: "1. Last day of Feb. 1440. A letter to thank the Duke [Humphrey] for 126 volumes brought by John Kyrkeby (f. 57^{b}): 2. Nov. 10, 1441. Letter acknowledging ten books . . . received through Will Say, proctor, and John Kyrkeby (ff. 59^{b}–60)." It appears probable that these citations allude to the John Kyrkeby in question.

As regards the remaining petitioners, it will be noted that the list of names is headed by that of Gilbert Kymer. This is significant, for he was not only Duke Humphrey's personal friend and physician, but a man of eminent scholastical and clerical influence.

Kymer[12] graduated as a doctor of medicine before 1420: he became Dean of Wimborne Minster and Treasurer of Salisbury Cathedral in 1427: he was Chancellor of Oxford from 1431–3; and again, from 1446–53. In 1447, he was one of the sureties in the carrying out of Cardinal Beaufort's bequest for the building of the new schools at Oxford. Elected Dean of Sarum on 16 June, 1449, he remain Dean until his death at Salisbury on 16 May, 1463.

According to Anthony à Wood, one of the windows in the library of Salisbury cathedral contained "not long since" an effigy of Kymer, together with a Latin epitaph[13]. Unfortunately, this window is no longer in existence[14].

[7] *Calendar of the Patent Rolls*, London, 1910, Vol. VI, p. 291.

[8] Thomas Rymer, *Foedera*, London, 1727, Vol. XI, p. 379.

[9] *Patent Rolls, op. cit.*, Vol. IV, p. 271.

[10] *Appendix to the History . . . of the Colleges . . . in the University of Oxford*, ed. John Gutch, Oxford, 1790, p. 46.

[11] W. D. Macray, *Annals of the Bodleian Library*, London, 1868, p. 7.

[12] *Cf. Dictionary of National Biography.*

[13] Anthony à Wood, *op. cit.*, p. 51. The epitaph is cited as follows:—

"In imaginem Doctoris Kymer Medici, quondam Cancellarii Oxon. et postea Decani Sarum.
O Sancti Medici, Medico mihi ferte juvamen;
Ut summus Medicus mentis mihi det medicamen,
Quo, sine fine salute poli post perfruar, amen".

[14] The Dean of Salisbury, Bishop R. H. Moberly, has kindly informed me that practically all their mediæval glass was lost during the 17th and 18th centuries.

It is evident that Kymer's interest in alchemy must have been known to Thomas Norton for, in his *Ordinall of Alchimy*[15], he says that:

> "*Gilbert Kymer* wrote after his devise,
> Of 17 Proportions, but thei maie not suffice
> In this *Science*, which he coude never finde;
> And yet in *Phisick* he had a nobil minde."

In two Oxford libraries, there are some MSS. which were written for Kymer[16]; but these works are concerned with medicine, not alchemy. The bindings, in both instances, are stamped on their covers with the bibliophilic aphorism "mon bien mondain".

The only other petitioner named in this document whose identity has been ascertained, is William Hatclyff[17]: a physician and secretary to Edward IV, he was one of the original scholars of King's College, Cambridge, appointed by Henry VI on 12 February, 1440. Hatclyff became one of the physicians chosen on 6 April, 1454 "to minister about the King's person in his sickness"[18]. He was also employed in diplomatic negotiations by both Henry VI and Edward IV, and he appears to have been very much *persona grata* at these courts.

A transcript of the document is given below, followed by a translation of the Latin draft of the *Letters Patent*[19]. In this draft, it will be observed that the first nine of the petitioners, namely Gylbert Kymer, John Faceby, William

[15] *Cf.* Elias Ashmole, *Theatrum Chemicum Britannicum*, London, 1652, p. 57. ("*Kymerus*" is spelt "*Rymerus*" by Maier on p. 133 of his *Tripus Aureus*, 1618, which contains the first printed Latin version of the *Ordinall*.)

[16] (*a*) Bodleian: MS. Laud 558. H. O. Coxe, *Catalogus Bibliothecae Laudianae*, Oxford, 1858–85, p. 402, describes this MS. as: "Codex membranaceus, in folio, Ff. 320, anno 1460 manu Hermanni de Gripesualdis apud Sarum bene exaratus, quondam Gilberti Kymer, decani Sarum, postea Petri Mounsell". The leather cover is stamped with two bands of recurrent inscriptions in gothic lettering. The outer one reads "mon bien mondain"; the inner one, "ihū m̄cy ladi help".

(*b*), Merton: MS. o.1.10. F. M. Powicke, *Mediæval Books of Merton College*, 1931, p. 245, s.n. No. 1256, says this MS. was written in 1458–9 by Hermann Zucke of Griepswald. It consists of two works, both in the same hand. The first colophon is dated 23 December, 1458, and the second colophon, which tells us that the scribe was Hermann, is dated 13 March, 1459 (i.e. 1460). The first colophon says that the work was written "in vio Draconum" (i.e. Dragon Hall Street, now Exeter Street, Salisbury). H. W. Garrod has inserted a slip to say it is a Salisbury binding. I am indebted to Dr. C. H. Josten for his information on the Bodleian MS.; and to Dr. J. Highfield who examined the Merton MS. for me.

[17] *Cf. Dictionary of National Biography*, under "Hatteclyffe".

[18] *Patent Rolls, op. cit.*, Vol. VI, p. 147. The other physicians were John Arundell, and John Faceby.

[19] I wish to record here my gratitude to Dr. C. H. Josten, Curator of the Museum of the History of Science, Oxford, for permission to publish this transcript of MS. Museum 84.

Hatclyff, John Kyrkeby, Wolfard Cook, Henry Welles, John Fouler, John Rayny, and John Morer, are described as "most learned in natural sciences"; whereas the remaining three persons, namely, Henry Bourgchier, John Solers, and William Lynde, are designated as "of fidelity and discretion".

It is possible that this Henry Bourgchier may have been related to the Lord Chancellor, Archbishop Thomas Bourgchier, whose brother—Henry—became Treasurer of the Kingdom on 29 May, 1455, and was created Earl of Essex in 1461, but no evidence can be advanced in support of this conjecture.

Transcript

To the kyng oure soverayn Lord M^{d} quod ista billa liberata fuit domino Cancellario Anglie xxxi die Maii apud Shene per manus Regis proprias exequenda.

Pleas it to youre Hyghnesse off youre most noble and benygne grace to grawnte to youre humble subgettes Master Gylbert Kymer Master John Faceby Master William Hatclyff Master John Kyrekeby Master Wolfard Cook Master Henry Welles Master John Fouler Master John Rayny Master John Morer Henry Bourgchier John Solers and to William Lynde your gracyous letturs patentes to theym under youre grete seel in due fourme accordyng to the tenour here folouyng and that eche off theym to whome it shall pleas so to have, shall now have the same severally w^{t} hym selff undre your seyd grete seel, paying bot vj^{d} for the same seel, consyderyd the gude ententes that they have for the gude publyke the grete costez labours and chargez that theym most have in executyng off the same lettres, and that the chawnceller off England for tyme beyng may seal to theym and eche off theym new letturs patentes to the same entent vayleable and suffycient w^{t} owt any more sute to be made to youre Hyghnes encase thys forme heer concevyd be not suffycient for theer suerte indempnyte and quyet off theer persones and theer gudes be thoccasyon off practyse off theer gude ententes, and that thys byll signed w^{t} your signe manuell yff it pleas youre hyghnes so to do may be sufficyent waraunt to yho^{r} chaunceller, and they shall pray god for yow.

Rex Omnibus ad quos etc salutem Sciatis quod cum antiqui sapientes et famosissimi philosophi in suis scriptis et libris sub figuris et integumentis docuerint et reliquerint ex vino, ex lapidibus preciosis, ex oleis, ex vegetabilibus, ex animalibus, ex metallis et ex medijs mineralibus multas medicinas gloriosas et notabiles confici posse, et presertim quandam preciosissimam medicinam quam aliqui philosophorum matrem et imperatricem medicinarum dixerunt, Alij gloriam inestimabilem eandem nominarunt, Alij vero quintam essentiam, lapidem philosophorum et elixir vite nuncupaverunt eandem, cuius medicine virtus tam efficax et admirabilis existeret quod per eam quecunque infirmitates curabiles curarentur faciliter, vita humana ad suum naturalem prorogaretur terminum, et homo in sanitate et viribus naturalibus tam corporis quam

anime, fortitudine membrorum, memorie claritate et ingenij viuacitate ad eundem terminum mirabiliter preservaretur, quecunque eciam vulnera curabilia sine difficultate sanarentur que insuper contra omne genus venenorum foret summa et optima medicina. Sed et plura alia comoda nobis et rei publice regni nostri utilissima per eandem fieri possent veluti metallorum transmutationes in verissimum aurum et finissimum argentum, nos frequenter meditacione multa revolvimus quam delectabile et quam utile tam pro nobis quam pro regni nostri Re Publica foret si huiusmodi medicine preciose diuina fauente gracia per labores haberentur virorum doctorum necnon quod a retroactis diebus et annis plurimis datum fuit paucis aut nullis ad veram praxim dictarum medicinarum gloriosarum pertingere, tum propter arduas difficultates circa earundem composicionem incidentes et circumstantes, tum quia timor penalis ab investigacione et practica tantorum secretorum multos viros ingeniosos naturalibus sciencijs doctissimos et ad earundem medicinarum practicas dispositissimos ab multis diebus hucusque abduxit abstraxit et distrahit in presenti ne ipsi in penam incidant cuiusdam statuti tempore regni Henrici aui nostri contra multiplicatores editi et provisi Quapropter congruum et expediens visum est nobis viros aliquos ingeniosos in sciencijs naturalibus sufficienter imbutos et ad practicandum dictas medicinas beniuolos et dispositos qui timeant deum, veritatem diligant et opera deceptoria et fallaces tincturas metallicas odiant, providere eligere et assignare quorum securitati indempnitati et quieti sufficienter ex nostra auctoritate et prerogativa regali prouideamus, ne vel dum in opere et practica fuerint ut post eorum labores et diligentias occasione huiusmodi practice quovismodo perturbentur inquietentur aut dampnificentur in personis aut bonis suis seu eorum aliquis perturbetur aut inquietetur in aliquo. Nos igitur confidentes de fidelitatibus, circumspectionibus, profundis sciencijs et benivolencijs egregiorum virorum Gilberti Kymer, Johannis Faceby, Willelmi Hatclyff, Johannis Kirkeby, Wolfardi Cook, Henrici Welles, Johannis Fowler, Johannis Rayny et Johannis Morer in sciencijs naturalibus eruditissimorum, necnon de fidelitatibus et discrecionibus Henrici Bourgchier, Johannis Solers et Willelmi Lynde elegimus assignavimus nominavimus et licenciavimus ipsos omnes et singulos ac ex nostra regali prerogatiua auctoritate et certa sciencia, ipsis et eorum cuilibet potestatem, auctoritatem, libertatem, warantam ac licenciam damus et concedimus specialem per presentes ad omnes et singulas medicinas predictas iuxta sciencias et discreciones suas et sapientum antiquorum doctrinas et scripta coniunctim et diuisim inquirendum investigandum principiandum prosequendum perficiendum et complete probandum necnon transmutaciones metallorum in verum aurum et verum argentum faciendem et excercendum [quamdiu placuerit eisdem aut alicui ipsorum ad aliquam dictarum medicinarum conficiendam practicare et laborare][20] statuto predicto aut quocunque alio statuto penali in contrarium

[20] These words are cancelled in the MS. by having a line drawn across them.

vel contra multiplicatores edito seu prouiso non obstante, dictos insuper Gilbertum, Johannem, Willelmum, Johannem, Wolfardum, Henricum, Johannem, Johannem et Johannem necnon dictos Henricum, Johannem et Willelmum ac eciam servitores suos quoscunque qui sibi, aliquibus aut alicui eorum in huiusmodi practica deseruierint, racione huiusmodi praxis et quemlibet eorum in defensionem nostram, tuicionem et protectionem nostram specialem ponimus et suscipimus per presentes, omnibus et singulis iudicibus, iusticariis, vicecomitibus, Maioribus, Balliuis, Constabularijs, Officiarijs, Ministris, veris Legeis et subditis nostris quibuscunque inhibentes ne ipsi eisdem aut eorum alicui pretextu dicti statuti aut cuiuscunque alterius coloris quesiti dum in practica premissarum medicinarum aut alicuius earum laborantes fuerint aut aliquis eorum laborans fuerit seu post complementum aut dimissionem practice earundem occasione huiusmodi praxis ullum gravamen impedimentum seu perturbationem quamcunque imponant aut inferant seu permittant inferri, seu aliquis eorum alicui ex eis imponat inferat aut permittat inferri, et si aliquid tale fiat, quod absit, mandamus omnibus officiariis et legeis nostris sicut nos timent et diligunt quod sine mora tale emendaretur grauamen sub pena in nostram gravem indignacionem incurrendi ac forisfaciendi nobis omnia que nobis forisfacere poterit quicunque hijs nostris scriptis contraueniens fuerit aut rebellis. Ex abundanti insuper dicimus et declaramus quod intencionis nostre regalis est quod hee littere nostre patentes valeant et sufficiant eis omnibus et eorum cuilibet necnon servitoribus suis ut ipsi securi quieti et indempnes sint et conserventur ab omnibus vexacionibus et inquietacionibus que contra eos aut eorum aliquem qualitercunque ex quacunque occasione cuiuscunque statuti contra multiplicatores editi seu provisi possent inferri. Datum etc.

Translation of the Latin Text

The King to all unto whom &c. Greeting. Know ye, that the sages and most famous philosophers of ancient times have taught, and recorded in their writings and books under signs and symbols, that many glorious and noteworthy medicines can be made from wine, precious stones, oils, vegetables, animals, metals, and certain minerals; and especially a most precious medicine, which some have called the mother of philosophers and Empress of medicines; others have named it the inestimable glory; others, indeed, have named it the quintessence, the philosophers' stone, and the elixir of life; a medicine whose virtue would be so efficacious and admirable that all curable infirmities would be easily cured by it; human life would be prolonged to its natural term, and man would be marvellously sustained unto the same term in health and natural virility of body and mind, in strength of limb, clearness of memory, and keenness of intellect; moreover, whosoever had curable wounds would be healed without difficulty; and it would also be the best and most perfect medicine

against all kinds of poisons. But also many other benefits, most useful to us and the well-being of our kingdom, could result from the same, such as the transmutation of metals into true gold and very fine silver; and we, by much frequent cogitation, have considered how delectable and useful it would be, both for ourselves and the well-being of the kingdom, if precious medicines of this kind were had, with God's grace, by the labours of learned men: also, that in days and years gone by, it was granted to very few, or none, to attain the true preparation of the said glorious medicines; sometimes on account of the arduous difficulties attending and surrounding the composition of the same; sometimes because fear of punishment prevented and drew away many talented men—most learned in natural sciences and very disposed to practise the same medicines—from the investigation and practice of such secrets, long since and until the present day; and turns them aside now, for fear of incurring the penalty of a certain statute of the time of Henry, our grandfather, given and provided against multipliers. On this account, it seemed fitting and expedient to us to provide, choose, and assign some talented men, sufficiently learned in natural sciences, and willing and disposed to practise the said medicines; men who fear God, seek truth, and hate deceitful work and the false tincturing of metals, to provide sufficiently for their security, indemnity, and tranquillity, by our authority and royal prerogative, that they be not disturbed, troubled, or injured in any way in their persons or goods, and that no one of them be troubled or disturbed in any way, by reason of this practice, neither while they are at their work and practice, nor after their labours and endeavours. We, therefore, trusting in the faith, circumspection, profound learning and good will of the worthy men Gilbert Kymer, John Faceby, William Hatclyff, John Kirkeby, Wolfard Cook, Henry Welles, John Fowler, John Rayny and John Morer, most learned in natural sciences, and the fidelity and discretion of Henry Bourgchier, John Solers and William Lynde, have chosen, assigned, nominated and licensed all and each of them, and of our royal prerogative, authority and certain knowledge, have given and granted to them and each of them by these presents, special power, authority, liberty, warrant and licence, to inquire, investigate, begin, pursue, complete and test absolutely, all and singular, the said medicines, according to their science and discretion and the doctrines and writings of the sages of old, together and individually, and also doing and practising the transmutation of metals into true gold and silver [as long as it pleases them or any of them to practise and work at making any of the said medicines][20] notwithstanding the said statute, or any other penal statute to the contrary, issued or provided against multipliers. We place and receive by these presents, by reason of this practice, in our special wardship, guardianship and protection, the aforesaid Gilbert, John, William, John, Wolfard, Henry, John, John and John, and also the said Henry, John, and William, and also all their servants who serve them, some or any one of them,

in this practice. We forbid all and singular our judges, justiciaries, sheriffs, mayors, bailiffs, constables, officers, ministers, true lieges and subjects, to inflict or do, or permit to be done to the same, or any of them, any harm, injury, or disturbance whatsoever, on account of this science; or any one of them to inflict or do or permit any such to be done to any one of them, under pretext of the said statute, or seeking any other excuse, while they or any one of them are working at the practice of the said medicines or any of them, or after the completion and cessation of the practice of the same. If anything such be done, which God forbid, we order all our officers and lieges, as they fear and wish to please us, that such injury be set aright without delay; whosoever disobeys and rebels against these our writings, being under pain of incurring our grave displeasure, and forfeiting to us all which can be forfeited to us. Furthermore, we add and declare that it is our royal intention that these our letters patent should be valid and sufficient to all and each of them and their servants, so that they may be tranquil and immune and kept from all vexations and disturbances which might be brought against them, or any of them, in any way, from the occasion of any statute passed or provided against multipliers. Given &c. . .

L. B. GUYTON DE MORVEAU (1737–1816)

A BIBLIOGRAPHICAL STUDY*

By W. A. SMEATON†

THE men whose names are most prominent in the history of science were, in general, either great experimental discoverers, or important contributors to the advancement of theory. Once the true value of their work is recognized, which may be only after their death, when it is seen in perspective, these men are remembered for ever. But there is a third kind of scientist—the great writer, teacher or critic—without whom the progress of the subject would be delayed, and he often enjoys a great reputation during his lifetime, but is almost forgotten after his death. Such a man was the subject of this study.

Louis Bernard Guyton was born at Dijon on 4 January, 1737, the son of Antoine Guyton, an advocate.

After receiving a classical education at the Godran College, which was conducted by Jesuits, he entered the Faculty of Law at Dijon in 1753, was admitted to the bar in 1756, and for six years practised as an advocate[1].

Dijon was the capital of Burgundy and the seat of one of the twelve provincial parliaments, or royal courts of law. A seat in a parliament, which carried with it social prestige and exemption from certain taxes, could be bought and sold, and in 1762 Guyton's father obtained for him the office of *avocat-général du Roi*, one of the public prosecutors, in the Dijon parliament. On taking

* This research was carried out in the Department of the History and Philosophy of Science, University College, London.

The locations of rare works are given in the footnotes, but it is not claimed that this information is complete.

BM = British Museum; BN = Bibliothèque Nationale, Paris; CS = Chemical Society, London; Dijon = Bibliothèque Publique, Dijon; FP = Faculté de Pharmacie, Paris; IF = Institut de France; PO = Patent Office, London; S = private collection of W. A. Smeaton; SG = Library of the Surgeon-General's Office, U.S. Army, Washington; W = Wellcome Historical Medical Library, London; UCL = University College, London; LC = Library of Congress, Washington.

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[1] Biographical information has been obtained largely from Georges Bouchard, *Guyton-Morveau, chimiste et conventionnel* (Paris, 1938). Another useful source has been A. B. Granville, "An account of the life and writings of Baron Guyton de Morveau", *Journal of Science and the Arts*, 1817, **3**, 249–96 (also published separately in the same year). Neither of these authors discussed Guyton's scientific work in any detail.

office Guyton added to his name "de Morveau", from the name of a family fief near Dijon; he retained this name, signing himself simply "De Morveau", until the French Revolution, when he became "Guyton-Morveau", then "Guyton" and finally "Guyton-Morveau" again[2].

In 1763 the French parliaments suppressed the Jesuit order. Much anti-Jesuit propaganda was circulated about this time, and to this Guyton contributed a long satirical poem, *Le rat iconoclaste ou le Jésuite croqué*[3], which was his first published work. The Jesuits had been largely responsible for French education, teaching little but Latin and theology, and after their suppression the parliaments asked for proposals for the reform of the educational system. On 18 March, 1764, Guyton submitted to the Dijon parliament a long *Mémoire sur l'éducation publique*[4], which was published and later translated into Spanish[5].

Guyton proposed that there should be in each province only one large college, to receive the best pupils from elementary schools in the small towns. In the old days the teachers had been members of a religious order, and the subjects taught were suitable mainly for the cloister, but Guyton considered it desirable for the teachers to be secular priests or laymen, teaching "the subjects which do not belong to any particular occupation, but belong to all"[6]; and he gave very detailed proposals for the curriculum. He had evidently studied the subject thoroughly, and gave many quotations from classical and modern authors.

Of special interest is Guyton's proposal that the final two years of the course should be devoted to philosophy, consisting of logic, metaphysics and ethics, mathematics and physics, all to be taught in French. He was very enthusiastic about the teaching of physics (which included natural history and chemistry), writing, "To the pupils will be presented the magnificent spectacle of the Universe and all its parts; the riches and the workings of Nature will be placed before their eyes . . . hypotheses will be confirmed by experiment . . .

[2] Many Frenchmen dropped "de" from their names when the monarchy weakened in 1792. A letter from Guyton to Vicq d'Azyr, the secretary of the Société de Médecine, written on 25 July, 1792, ends with the words "je présente à mon très illustre confrère l'assurance de mon respectueux attachement. Guyton-Morveau. P.S. je le prie d'inscrire ma signature comme cidessus, pour qu'on ne me croie pas attaché à l'ancien ordre". (Library of the Académie de Médecine, Paris, MS. 33, f. 122.)

[3] *Le Rat iconoclaste ou le Jésuite croqué. Poëme heroi-comique en vers et en six chants*, 12 mo., pp. vi + 53, n.p., 1763 (BM, BN, LC).

[4] *Mémoire sur l'éducation publique, avec le prospectus d'un collège suivant les principes de cet ouvrage. Par M. Guyton de Morveau*, 12 mo., pp. 324, n.p., 1764 (BN, IF, UCL).

[5] *Tratado de la educacion pública, con la planta de un colegio, segun los principios, que se establecen en esta obra . . . traducido del frances, por d. Josef Antonio Porcél . . .* 12 mo., pp. 381, Madrid, *J. Ibarra*, 1768 (LC).

[6] *Mémoire sur l'éducation publique*, p. 55.

and this study, freed from the yoke of pedantry, will become the most agreeable and instructive of occupations"[7].

Guyton's *Mémoire* was praised, but few of his proposals were adopted. The Jesuit teachers at the Godran College were replaced, but there was little change in the curriculum.

Guyton performed his heavy parliamentary duties ably and conscientiously until his retirement in 1782, when he was given the title of *avocat-général honoraire*, together with a pension and certain hereditary privileges. During his twenty years of office he had taken part in many legal cases and made speeches on a great variety of topics. The most important of these were published in the three volumes of his *Discours publics et éloges*[8], and in his *Plaidoyers sur plusieurs questions importantes de droit*[9].

One of the most important speeches was the "Discours sur l'état actuel de la Jurisprudence"[10], delivered in 1767, in which Guyton again showed his desire for reform by criticizing the many local laws in France, where there were, he said, one people, one legislator and 285 different legal codes. In 1771 he outlined a scheme for a completely new code, applicable to the whole country, to be drawn up by a committee of legal experts[11]; but the destruction of the old system, like that of education, came only with the Revolution, and its satisfactory reform, with Napoleon.

On 20 January, 1764, Guyton was elected an *honoraire* of the Academy of Sciences, Arts and Belles-Lettres of Dijon[12]. At first he contributed only poems and orations, but he seems, like many educated men of the day, to have been interested in science, and it was said by Granville that he started to practise chemistry after challenging some remarks on a chemical topic by Dr. J. P. Chardenon. On being told by Chardenon to rest content with his literary reputation and to leave chemistry to the specialists, Guyton set to work to master the subject. He studied the books of Macquer and Baumé; he bought apparatus and materials from a young man who had housed an itinerant alchemist for six months, with no profit to himself, but to the great benefit of the

[7] *Ibid.*, p. 272.

[8] *Discours publics et éloges, auxquels on a joint une lettre où l'auteur développe le plan annoncé dans l'un de ses discours, pour réformer la jurisprudence, par M. ***, Avocat Général*, 12 mo. Vol. I, pp. xi + 294; Vol. II, pp. 308; Vol. III, pp. 372; Paris, *P.-G. Simon*, 1775, 1774 [*sic*], 1782 (BM, BN, IF).

[9] *Plaidoyers sur plusieurs questions importantes de droit canonique et civil . . . Par M. Guyton de Morveau*, 4to, pp. xxxvi + 677, Dijon, *Mailly*, and Paris, *Théophile Barrois jeune*, 1785 (BM, Dijon, IF).

[10] *Discours publics et éloges*, Vol. I, pp. 47–103.

[11] *Ibid.*, pp. 135–294.

[12] Historical information about the Dijon Academy has been obtained mainly from Ph. Milsand, *Notes et documents pour servir à l'histoire de l'Académie . . . de Dijon*, 2nd ed., Paris, 1871.

alchemist; and he went to Paris, where he visited Baumé and other chemists, and bought books, chemicals and instruments. In 1768 Guyton acquired a house in the Place St. Jean (now the Place Bossuet) in Dijon, fitted it with a laboratory, and thenceforth devoted to chemistry all the time that he could spare from his parliamentary duties. He read papers to the Academy on many topics; most of them were published either in the *Mémoires* (later the *Nouveaux Mémoires*) of the Dijon Academy, or in Rozier's *Observations sur la Physique*[13].

Guyton's first scientific publication was a "Mémoire sur les phénomènes de l'air dans la combustion", read to the Academy on 11 December, 1768[14], in which he described experiments that led him to believe that, while air was necessary for combustion to take place, its action was purely mechanical, and it was not partly consumed, as had been suggested by Hales. Guyton intended to collaborate with Chardenon in an extensive research on combustion and calcination, but Chardenon died in 1769 and Guyton carried on alone.

At this time nearly all chemists accepted the theory that phlogiston was lost from a body during its combustion or calcination, but there were many opinions about the nature of phlogiston. Guyton's conclusions were presented in 1772 in a "Dissertation sur le phlogistique", the first and longest of three essays in a volume entitled *Digressions Académiques*[15]. He first established that there was invariably an increase in weight when a metal was calcined, showing that the decrease reported by some earlier workers was due only to mechanical loss or volatilization; he then gave critical accounts of the theories of Boyle, Kunckel, Boerhaave, Hales, Béraut, Chardenon, Gellert, Meyer and Scheffer; and finally he developed, in a logical manner, his theory that the presence or absence of phlogiston was the only cause of the change in weight. He believed that phlogiston was specifically lighter than any other substance, even the most subtle, and therefore caused an apparent diminution in the weight of any substance with which it was combined, in whatever medium the substance was weighed. This essay was criticized by an anonymous reviewer[16], whose objections were, however, unsound, and were easily dismissed by Guyton in a pamphlet published in the same year[17]. A more serious attack was made by another anonymous reviewer[18], possibly Lavoisier, who exposed

[13] The present paper does not include a full list of Guyton's contributions to periodical publications, which numbered about 160.

[14] *Mém. Acad. Dijon*, 1769, **1**, 416–38.

[15] *Digressions Académiques, ou essais sur quelques sujets de physique, de chymie & d'histoire naturelle*, 12mo, pp. xvi + 417, Dijon, *L. N. Frantin*, and Paris, *P. F. Didot le jeune*, 1772. (See also footnotes 21 and 22.)

[16] *J. de Médecine*, 1772, **38**, 195.

[17] *Défense de la volatilité du phlogistique, ou lettre de l'auteur des Digressions Académiques, etc.*, 12mo, pp. iv + 39, Dijon, *L.N . Frantin*, 1772 (BN).

[18] *Obs. sur la Phys.*, 1773, **2**, 281.

the fallacies of Guyton's arguments, and to whom Guyton made no reply. Guyton's theory and the criticisms of it have been fully discussed by Partington and McKie[19].

The other important essay in *Digressions Académiques* was an "Essai physico-chymique sur la dissolution et la crystallisation", in which Guyton advanced for the first time his theory that chemical affinity was caused by forces of attraction between the ultimate particles of matter, and that from a study of the phenomena of crystallization it should be possible to infer the shapes of these ultimate particles and to calculate the forces of attraction[20]. The third essay was a short "Observation sur une nouvelle espèce de Guhr".

Partington and McKie[21], who consulted the copy in the library of Edinburgh University, have pointed out that, although *Digressions Académiques* was published in 1772, the title-page bears the date M.DCC.LXII (Plate II, Fig. 1). Of seven other copies that have been examined, five[22] have the same title-page as the Edinburgh copy; none of these has a half-title, and the collation does not call for one. However, in two copies[23], this incorrect title-page has been removed, and replaced by one with the correct date M.DCC.LXXII (Plate II, Fig. 2); while making this correction the printer re-set the title-page and improved its appearance by transferring the quotation from Cicero to the verso, and he also added a half-title. In all other respects the seven copies are identical.

On 17 November, 1774, Guyton read to the Academy a memoir in which he showed the desirability of a public course of chemistry in a provincial city such as Dijon[24]. The Academy had recently moved into a new building with a laboratory, and possessed collections of natural history; lecturers were available; all that was needed was an annual sum of money to pay the wages of a laboratory steward and to purchase apparatus and materials. The money was granted by the States-General of Burgundy, and the first course was opened on 28 April, 1776; it lasted three months, with lectures and demonstrations three times weekly. Guyton planned the course and gave most of the lectures, with the assistance of Dr. H. Maret on materia medica, and Dr. J. F. Durande on the chemistry of vegetable substances.

The contents of the course were published in 1777–8 in three volumes entitled *Elémens de chymie . . . pour servir aux cours publics de l'Académie de*

[19] *Annals of Science*, 1937, **2**, 388–400.

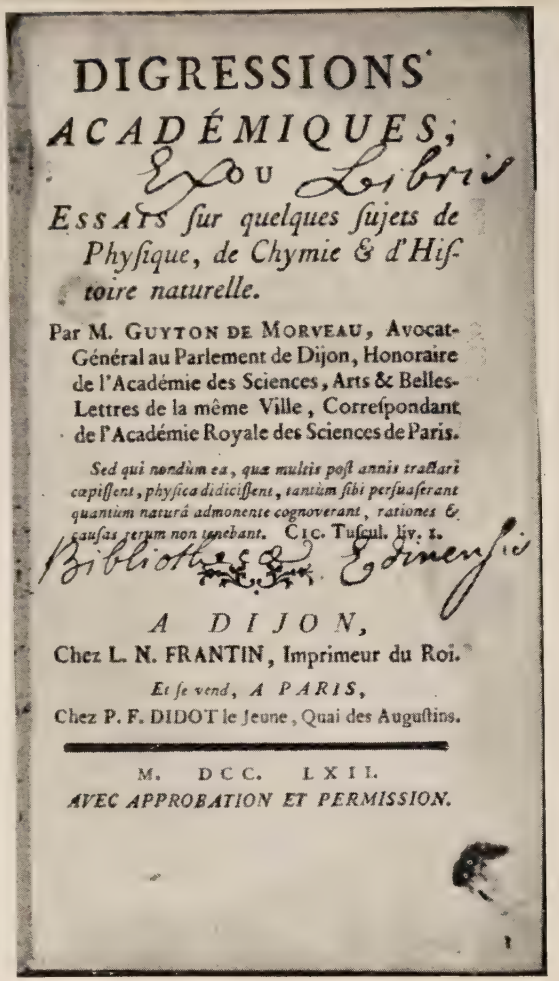
[20] It is hoped to give an account of Guyton's views on affinity in a later paper.

[21] *Loc. cit.*, see footnote 18.

[22] BN; FP; PO; Ecole Normale Supérieure, Paris; and Bibliothèque Ste- Geneviève, Paris.

[23] IF and S.

[24] *Mémoire sur l'utilité d'un cours public de chymie dans la ville de Dijon, les avantages qui en résulteroient pour la province entière, et les moyens de procurer à peu de frais cet établissement*, 4to, pp. 19, Dijon, *L.-N. Frantin*, 1775 (Dijon, IF).



DIGRESSIONS
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OU
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ESSAIS *ſur quelques ſujets de Phyſique, de Chymie & d'Hiſtoire naturelle.*

Par M. GUYTON DE MORVEAU, Avocat-Général au Parlement de Dijon, Honoraire de l'Académie des Sciences, Arts & Belles-Lettres de la même Ville, Correſpondant de l'Académie Royale des Sciences de Paris.

Sed qui nondùm ea, quæ multis poſt annis tractari cœpiſſent, phyſica didiciſſent, tantùm ſibi perſuaſerant quantùm naturâ admonente cognoverant, rationes & cauſas rerum non tenebant. CIC. Tuſcul. liv. 1.

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M. DCC. LXII.
AVEC APPROBATION ET PERMISSION.

Fig. 1. By courtesy of the University of Edinburgh

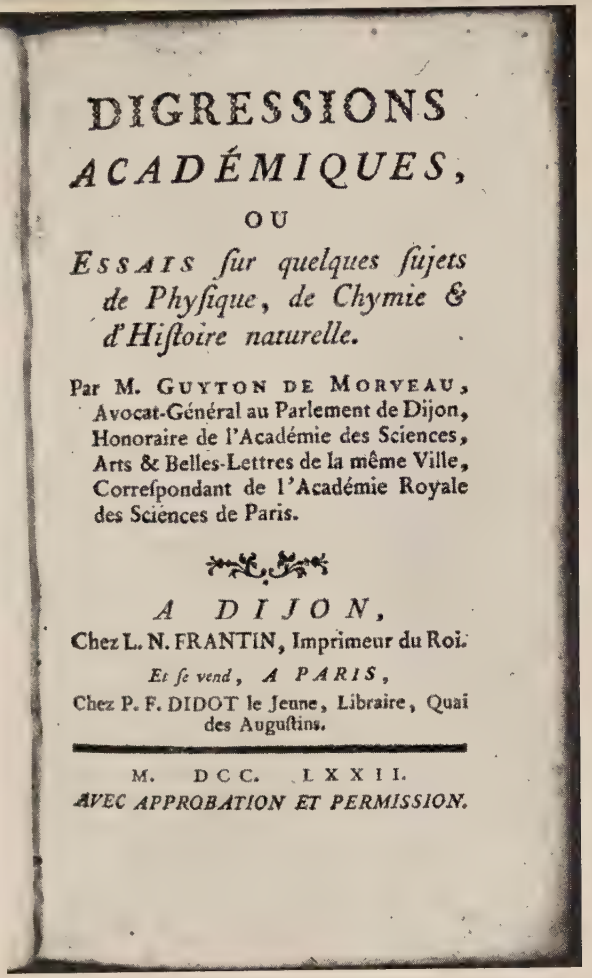

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Fig. 2.

Dijon[25]. The arrangement of the work was governed by Guyton's theory that the mutual attraction between the ultimate particles of different kinds of matter could cause one substance to dissolve in another, and that a chemical change was possible only as a result of such a solution. Each chemical operation therefore required a *solvent*, and a *base*, or dissolved substance. Twenty solvents were recognized: the three simple elements, fire, air and water; nine acids; the three alkalis; four oil substances, spirit of wine, ether, essential oil and fatty oil; and mercury, a metallic fluid. A chapter was devoted to each solvent; its occurrence in nature and method of extraction, its properties, and its action, if any, on each of thirty bases were discussed in a systematic order[26]. Thirteen of the chapters were written by Guyton, who drew up the plan of the work and reviewed the whole manuscript to ensure consistency in all its parts[27]. Although the course of lectures was revised each year there was no second edition of the book, but it was translated into German[28] and Spanish[29].

During a visit to Paris in 1775, Guyton had been introduced to pneumatic chemistry by Lavoisier, and in his course at Dijon he demonstrated Lavoisier's experiments. He was now convinced that air was absorbed during combustion and calcination, and he developed a theory similar to that of P.-J. Macquer, believing that the absorption of air was accompanied by the emission of phlogiston. This theory was taught in the course and published in the *Elémens de chymie* and Guyton's other writings before 1787.

[25] *Elémens de chymie, théorique et pratique, rédigés dans un nouvel ordre, d'après les découvertes modernes, pour servir aux cours publics de l'Académie de Dijon*, 12mo. Vol. I, pp. viii + 394; Vol. II, pp. xviii + 382; Vol. III, pp. x + 448; Dijon, *L.-N. Frantin*, 1777, 1777, 1778 (BM, BN, FP, S, UCL).

[26] The bases were fire, air and water; the four earths; the three alkalis; eight metals and six semi-metals; six oily substances, bitumen, essential oil, fatty oil, resin, gum and spirit of wine. Some substances could act as either a *solvent* or a *base*; in any particular reaction the name *solvent* was given to the more essentially fluid of the two substances.

[27] This was stated in Vol. II, p. xxi.

[28] *Anfangsgründe der theoretischen und practischen Chemie, zum Gebrauch der öffentl. Vorlesungen auf der Acad. zu Dijon, nach den neuern Entdeckungen in eine neue Ordnung gebracht, von den Herren de Morveau, Maret und Durande. Aus dem Französischen übersetzt mit Anmerkungen von Christ. Ehrenfr. Weigel*, 8vo. Vol. I, pp. (12) + 316; Vol. II, pp. (20) + 276; Vol. III, pp. (10) + 333; Leipzig, *S. L. Crusius*, 1779, 1780, 1780 (BM).

[29] *Elementos de química teórica y práctica, puestos en un nuevo orden despues de los mas modernos descubrimientos, por MM. Morveau, Maret y Durande, individuos de la Academia de Dijon; y traducidos al castellano por Don Melchor de Guardia y Ardevol*, 4to, pp. (6) + 576, Madrid, *Benito Cano*, 1788 (Biblioteca Nacional, Madrid).

One copy of another Spanish translation has been located (W). It is a quarto volume of 671 pp., but lacks the title-page and all pages before p. 263. The Spanish title and place and date of publication are therefore unknown, but it must have been published after 1787, for the nomenclature used is a Spanish adaptation of that introduced in 1787 by Guyton, Lavoisier and others.

Guyton's correspondence with P.-J. Macquer[30] shows that he would have liked to live in Paris, and in 1779 Lavoisier unsuccessfully nominated him for a legal post in the Mint. Guyton continued to live at Dijon until 1790, but, although he had few opportunities to meet the leading chemists of the day, he corresponded with most of them.

One of Guyton's regular correspondents was Torbern Bergman, of Upsala, and, feeling that Bergman's work should be better known, he translated the first two volumes of Bergman's *Opuscula Physica et Chemica*, under the title *Opuscules Chymiques et Physiques*[31]. He added many notes, with the approval of Bergman, who supplied corrections and additions during the printing of these volumes, which appeared in 1780 and 1785. In collaboration with others at Dijon, Guyton translated many memoirs from several languages; most of these were printed in *Observations sur la Physique*, and were of great value to French scientists.

In 1785 a translation of Scheele's collected memoirs was published in Dijon[32]. Guyton added some notes, but most of the translation was the work of Madame Picardet, the wife of another Dijon academician. She assisted Guyton in many ways, and was described by Arthur Young as "a very pleasing unaffected woman . . . a treasure to M. de Morveau, for she is able and willing to converse with him on chymical subjects, and on any others that tend either to instruct or please"[33]. Madame Picardet married Guyton in 1798, after the death of her first husband.

Guyton, with his desire for reform, could not long tolerate the antiquated and inconvenient chemical nomenclature then in use[34]. Macquer and Bergman

[30] Eighteen letters from Guyton to Macquer have been preserved (BN: MS. français 12306, ff. 123–57). The first of these is dated "14 avril 1762"; this date is quoted without comment by Bouchard (*op. cit.*, p. 55, see footnote 1), but the contents of the letter show that this was due to a slip of the pen, and that the correct date should be 1769. With the letter Guyton sent his "Observation sur une effervescence froide", read to the Dijon Academy on 14 April 1769 (*Mém. Acad. Dijon*, 1774, **2**, 183–90), and he referred to the death of Chardenon, which occurred on 16 March 1769 (Partington and McKie, *Annals of Science*, 1938, **3**, 58).

[31] *Opuscules chymiques et physiques de M. T. Bergman . . . receuillis, revus, et augmentés par lui-meme, traduits par M. de Morveau, avec des notes*, 8vo. Vol. I, pp. xxxi + 446; Vol. II, pp. xvi + 525; Dijon, *L. N. Frantin*, 1780 and 1785 (Vol. I, BM, BN, Dijon, FP, S; Vol. II, Dijon, FP, S). The Italian and Spanish translations of Bergman's *Opuscula* were based on Guyton's translation, according to Birgitta Moström, *Torbern Bergman, A Bibliography of his Works*, Stockholm, 1957, items 280, 281a and 295.

[32] *Mémoires de Chymie de M. C. W. Schéele, tirés des Mémoires de l'Académie Royale des Sciences de Stockholm, traduits du Suedois et de l'Allemand*, 12mo. *Première partie*, pp. vi + 269; *Seconde partie*, pp. vi + 246; Dijon, *Chez l'Editeur, Place Saint-Fiacre*; Paris, *Théophile Barrois le jeune* and *Cuchet*, 1785 (BM, BN, FP).

[33] A. Young, *Travels . . . (in) the Kingdom of France*, Bury St. Edmunds, 1792, p. 151.

[34] W. A. Smeaton, "The contributions of P.-J. Macquer, T. O. Bergman and L. B. Guyton de Morveau to the reform of chemical nomenclature", *Annals of Science*, 1954, **10**, 87–106.

had proposed certain reforms, and Guyton had been influenced by both of them when, in 1780, he was commissioned by the publisher Panckoucke to write the chemical volumes of the *Encyclopédie Méthodique*. All the articles were arranged alphabetically in Diderot's *Encyclopédie*, so that the chemistry, written by Venel, was scattered through the entire work. The same plan had been followed in the four supplementary volumes, published in 1776–7, to which Guyton had contributed the chemical articles[35], but in the new work all the chemistry was kept together in six volumes, of which Guyton wrote most of the first[36]. He realized that he now had a chance to perfect the language of the science, and in May, 1782, he published his reforms in the "Mémoire sur les dénominations chymiques"[37]. The first half-volume of the *Encyclopédie Méthodique, Chymie, Pharmacie et Métallurgie* contained the long and important article "Acide", in which Guyton gave a very full account of all the known acids and their salts, and his proposals of 1782 were concerned mainly with these substances. His nomenclature was well received; it was adopted by A. F. de Fourcroy and other authors, and forms the basis of the modern nomenclature of salts.

After Guyton's retirement from the parliament in 1782 he devoted nearly all his time to chemistry, and was kept very busy with the writing of the encyclopaedia, the translation of Bergman's essays, various experimental researches, and the revision of the annual course. But he was still able to turn boldly to the pursuit of a new science. On 21 November, 1783, J. F. Pilâtre de Rozier and the Marquis d'Arlandes made the first passenger flight in the Montgolfier brothers' hot-air balloon, followed on 1 December by Charles and Robert in the first hydrogen balloon. These flights attracted widespread interest, and on 4 December the Academy decided to carry out aerostatic

[35] D. Diderot, *Supplément à l'Encyclopédie*, 4 vols, Amsterdam, 1776–7 (BM, BN, UCL). Guyton wrote the following articles: *Affinité, Air, Air fixe, Alkali phlogistiqué, Calcination, Causticité, Causticum, Combustion, Crystallisation, Crystallographie, Dissolution, Equiponderance, Hépar, Phlogistique.*

[36] *Encyclopédie Méthodique, Chymie, Pharmacie et Métallurgie. La Chymie, par M. de Morveau. La Pharmacie, par M. Maret. La Métallurgie, par M. Duhamel.* Vol. I, 4to, pp. viii + 774; Paris, *Panckoucke*, and Liège, *Plomteux*. The first part was published in 1786, the date on the title-page; the colophon at the end of the second part (p. 774) is dated 1789, and shows that it was printed in Dijon by L. N. Frantin. Generally, both parts are bound together in one volume, but one copy (PO) is in two parts, in the original boards; part two, which has no separate title-page, begins with the article "Acidifiable" on p. 417.

Volumes II–V, written by Fourcroy, appeared in 1792, 1796, 1805 and 1808, and Vol. VI, completed by Vauquelin after Fourcroy's death, in 1815; the volume of plates was published in 1813.

[37] *Obs. sur la Phys.*, 1782, **19**, 370–82. Extracts have been published by R. Jagnaux (*Histoire de la Chimie*, Paris, 1891, pp. 178–80) and E. W. J. Neave (*Annals of Science*, 1952, **8**, 34–37).

experiments at Dijon. A hydrogen balloon was constructed, and on 25 April, 1784, Guyton, who was in charge of the project, made a flight of about fifteen miles, accompanied by Bertrand. He made another flight with de Virly on 12 June, and this time an effort was made, with only slight success, to steer the balloon by means of oars and a rudder. Guyton described the principles and construction of the machine, and gave an account of his flights, in the *Description de l'aérostate, l'Académie de Dijon*[38], of which he was the chief author. He showed a clear understanding of the problems of the flight and dirigibility of balloons, and, in reviewing the book, Lalande described it with justice as "a veritable treatise on aerostatic machines which will always be read with interest, even when the art is perfected". Of particular interest to chemists is the chapter containing Guyton's comparative account of the different inflammable gases, obtained by the action of metals on acids, of heat on organic substances, and in other ways.

In 1786 Guyton began to write the second half-volume of chemistry for the *Encyclopédie Méthodique*[39]. This contained the article "Air", in which he gave an account of all the different kinds of air (i.e. the different gases), and he was faced with the problem of their nomenclature. Most of his proposals of 1782 were acceptable to phlogistonists and anti-phlogistonists alike, but it was impossible to devise a nomenclature for gases which would be applicable to both systems. Guyton was at this time still trying to reconcile the phlogiston theory with the experimental discoveries of Lavoisier and others, but early in 1787 he went to Paris, where he soon followed C. L. Berthollet and A. F. de Fourcroy in accepting the anti-phlogistic theory[40]. He collaborated with Lavoisier, Berthollet and Fourcroy in revising the nomenclature of all substances so that their names expressed their compositions according to the new theory. Lavoisier explained the principles of the new nomenclature to the Academy of Sciences on 18 April, 1787, and on 2 May, Guyton gave an account of the new names, explained the reasons for their choice, and gave examples in tabular form. Later in the year these two memoirs, together with synonymies of the old and new names and contributions by Fourcroy, Hassenfratz

[38] *Description de l'aérostate* [*sic*] *l'Académie de Dijon, contenant le détail des procédés, la théorie des opérations, les dessins des machines et les procès-verbaux d'expériences, le tout extrait du compte rendu à cette Société par MM. de Morveau, Chaussier et Bertrand . . .*, 8vo, pp. v + 224, Dijon, *Causse*, 1784 (BN, IF, LC, PO). Reviewed by Lalande in *J. des Scavans*, January, 1785, pp. 44–46.

[39] This was not published until 1789 (see footnote 36), but in a letter written on 7 September, 1786 to P. Picot, Baron de la Peyrouse, Guyton stated that the Article "Acier" had already been printed (Muséum d'Histoire Naturelle, Paris, MS. 1992, no. 474).

[40] An account of the conversion of Guyton and others to Lavoisier's doctrines has been given by D. I. Duveen and H. S. Klickstein, *Osiris*, 1956, **12**, 342–67.

and Adet, were published in one volume entitled *Méthode de Nomenclature Chimique*[41].

Guyton remained in Paris until about the beginning of September[42], and after his return to Dijon became one of the most vigorous exponents of the new chemistry. In December, 1787, he taught the anti-phlogistic theory in his course at the Academy, and he collaborated with Lavoisier and his colleagues in writing the notes for the French translation of Richard Kirwan's *Essay on phlogiston* (London, 1787); these notes were added at the end of each chapter, replying to Kirwan's phlogistic arguments[43]. The translation is generally ascribed to Madame Lavoisier. She discussed it with Arthur Young on 13 September, 1787[44], but soon afterwards she accompanied Lavoisier on a visit to Dijon[45], and it may then have been decided that Madame Picardet should translate part of the book. This would explain Young's later statement that Madame Picardet "translated Scheele from the German, and a part of Mr. Kirwan from the English"[46].

[41] *Méthode de Nomenclature Chimique, proposée par MM. de Morveau, Lavoisier, Bertholet [sic], & de Fourcroy. On y a joint un nouveau système de caractères chimiques, adaptés à cette nomenclature, par MM. Hassenfratz & Adet.*, 8vo, pp. (iv) + 314, Paris, *Cuchet*, 1787. A full bibliographical account of this work with its seven French issues and editions, and translations into English, German, Italian and Spanish, has been given by D. I. Duveen and H. S. Klickstein, *A Bibliography of . . . Lavoisier*, London, 1954, pp. 119–54. The only full English translation, by James St. John, was published as *Method of Chymical Nomenclature . . .*, 8vo, pp. xvi + 238, London, 1788 (CS).

[42] The minutes of the Paris Academy of Sciences state that on 29 August, 1787, Guyton and Lavoisier presented a copy of the *Méthode de Nomenclature Chimique*; however, the book was not generally available while Guyton was in Paris, for on 13 September he wrote from Dijon to P.-L. Baudot, in Paris, saying, "Our nomenclature has just appeared; I have been sent several copies and have been told that I shall receive a share of those that are left after copies have been sent to the foreign academies" (Dijon, MS. 1181, f. 164).

[43] *Essai sur le phlogistique, et sur la constitution des acides, traduit de l'anglois de M. Kirwan; avec des notes de MM. de Morveau, Lavoisier, de la Place, Monge, Berthollet & de Fourcroy*, 8vo, pp. xii + 348, Paris, *Rue et Hôtel Serpente*, 1788 (BM, BN, CS, FP). Guyton contributed notes to two sections (pp. 170–75 and 329–44). This work, with the notes, was translated into English and German. The English translation, by Wm. Nicholson, is entitled *An Essay on Phlogiston, and the Constitution of Acids . . .*, 8vo, pp. xxiii + 317, London, 1789 (BM). Full details of this work have been given by D. I. Duveen and H. S. Klickstein, *A Bibliography of . . . Lavoisier*, London, 1954, pp. 277–81.

[44] A. Young, *op. cit.*, p. 64 (see footnote 33); quoted by D. I. Duveen, *Chymia*, 1953, **4**, 17.

[45] This was stated by Guyton in a letter to P.-L. Baudot, dated 20 October, 1787; Lavoisier was accompanied by Fourcroy, Vandermonde and Monge, and Madame Fourcroy was also present (Dijon, MS. 1181, f. 165). The visit probably took place at the end of September, for the minutes of the Société Royale de Médecine show that Fourcroy was absent from five meetings, between 18 September and 2 October (Acad. de Médecine, Paris, MS. 11).

[46] A. Young, *loc. cit.* (see footnote 33); it is, however, possible that Young was referring to the translations of several of Kirwan's papers which Mme. Picardet had published in *Obs. sur la Phys.*

The anti-phlogistic chemists found it difficult to publish their work in France, for the *Mémoires* of the Paris Academy of Sciences were badly in arrears, the *Journal des Savants* had given little space to chemistry since Macquer's death, and J. C. de la Métherie, the new editor of *Observations sur la Physique*, was strongly opposed to the new theories. After some difficulties Lavoisier and his colleagues founded in 1789 a new journal, *Annales de Chimie*; Guyton was one of the editors, and to its pages he contribute many memoirs, translations and extracts from his correspondence.

It was also in 1789 that the second half-volume of the *Encyclopédie Méthodique, Chymie, Pharmacie et Métallurgie* was published; for Guyton's convenience it had been printed in Dijon, and it included a second preface, in which Guyton explained his conversion to the anti-phlogistic theory. In addition to the article "Air", this half-volume included the important article "Affinité", in which Guyton developed his own ideas on the subject and also gave a critical account of other theories of affinity. Guyton had carried out very thoroughly his task of writing the first volume of chemistry for the *Encyclopédie Méthodique*. He taught himself several languages, and gave excellent historical surveys of the parts of chemistry with which he dealt; he arranged the material in a very orderly manner, and presented it in his usual lucid style. Maret and Duhamel contributed some articles on pharmacy and metallurgy respectively, but by far the greatest part of the book was by Guyton, and, its excellence being generally recognized, it earned for its author a prize of 1,200 livres from the Paris Academy of Sciences in 1793. Guyton immediately presented his prize to the National Treasury.

Parts of Guyton's volume of the *Encyclopédie Méthodique* were translated; the article "Acide" into German[47], and the article "Affinité" into German[48], Italian[49] and Portuguese[50].

[47] *Guyton-Morveaus, Mitgliedes verschiedener Akademien, allgemeine theoretische und praktische Grundsätze über die sauren Salze oder Säuren zum Gebrauch für Chemisten, Aerzte, Apotheker und Fabrikanten, aus dem Französischen übersetzt und mit Anmerkungen versehen von David Ludewig Bourguet . . . mit einer Verrede begleitet von Dr Sigismund Friedrich Hermbstadt*, 8vo. Vol. I, pp. viii + iv + 583; Vol. II, pp. vi + 362 + 66; Berlin; *Gottlieb August Lange*, 1796 and 1797 (W). H. C. Bolton (*Select Bibliography of Chemistry*, Washington, 1893, p. 505) record Vol. III, 1804, but this has not been located; it probably contains the translation of Guyton's articles on the organic acids, which are not in Vols. I and II.

[48] *Des Herrn Guyton Morveau, Mitgliedes der Akademie der Wissenschaften zu Paris, allgemeine theoretische und praktische Grundsätze der chemischen Affinität oder Wahlanzichung zum gemeinnutzigen Gebrauch für Naturforscher, Chemisten, Aerzte und Apotheker, aus dem Französischen übersetzt von David Joseph Veit, mit Anmerkungen begleitet und herausgegeben von D. Siegesmund Friedrich Hermbstadt*, 8vo, pp. xvi + 320, Berlin, *Heinrich August Rottmann*, 1794 (Bibliothèque du Muséum d'Histoire Naturelle, Paris).

[*Continued on next page.*

During these crowded years in Dijon, Guyton carried out a considerable amount of experimental work, but little of it was of lasting value. Like most of his contemporaries he recognized no distinction between "pure" and "applied" chemistry, and much of his research was concerned with the applications of science to the arts and manufactures. He studied the composition of mortars and cements[51]; he found that as a pigment, zinc oxide was a good substitute for the poisonous white lead[52]; and he showed that cast iron, wrought iron and steel differed only in their carbon content[53]. Several times he ventured into industry himself. His most successful undertaking was a glassworks, run in conjunction with a coalmine; but he soon had to close a soda factory in Britanny, which utilized a reaction between brine, slaked lime and carbonic acid from the air. He produced nitre for a few years at Dijon, but in 1788 disposed of the business to J.-B. Courtois, the laboratory steward of the Academy and father of the future discoverer of iodine; this interest had led Guyton to devise a method of analysing the mother-liquor of nitre, in which volumetric analysis was used[54].

Being particularly interested in the analysis of minerals, Guyton was often consulted by the directors of mines and foundries, and he corresponded and exchanged specimens with other mineralogists. The descriptions of minerals were very unsystematic until 1774, when A. G. Werner published a clear and uniform method of description[55]. Wishing this reform to be widely known,

[49] *Esame delle affinità chimiche di tutti i relativi sistemi de' più celebri chimici d'Europa. Opera del Sig. Morveau . . . recata dalla Francese . . . da Vincenzo Dandolo Veneto, coll' aggiunta di alcune annotazioni, che serve di supplemento alla traduzione del Trattato Elementare di Chimica del Sig. Lavoisier, Tomo terzo*, 8vo, pp. xii + 347, Venezia, 1791 (BN). Volumes I and II contain a translation of Lavoisier's *Traité élémentaire de chimie*, and Volume IV a translation of the new system of nomenclature.

[50] *Tractado das Affinidades Chimicas: Artigo, Que no Diccionario de Chimica, fazendo parte da Encyclopedia por ordem de materias, deu Mr. de Morveau: e que para commodidade de seus discipulos. Traduzio Thomé Rodrigues Sobral*, 8vo, pp. (10) + v + 512, Coimbra, *Real Imprensa de Universidade*, 1793 (University Library, Coimbra).

[51] Guyton's method of making a waterproof mortar, invented by Loriot, was described in *Obs. sur la Phys.*, 1774, **4**, 416–25 and 1775, **6**, 311–15, and it was published separately in *Instruction sur la nouvelle méthode de préparer le mortier Loriot*, 8vo, pp. 15, Paris, *J. Barbou*, 1775 (BN).

[52] *Nouv. Mém. Acad. Dijon*, 1782 (1st semestre), 1–24.

[53] *Encyclopédie Méthodique, Chymie, Pharmacie et Métallurgie*, article "Acier" in Vol. I, pp. 420–51, written in 1786. The part played by carbon was discovered independently by Berthollet, Vandermonde and Monge (*Obs. sur la Phys.*, 1786, **29**, 210–21); on 7 October, 1786, Guyton wrote to Berthollet to explain that he had reached the same conclusion, but had not yet published it, and Berthollet published the letter (*Obs. sur la Phys.*, 1786, **29**, 308–12).

[54] *Nouv. Mém. Acad. Dijon*, 1782 (2nd semestre), 1–26. It is intended to publish separately a full account of the work of Guyton and others on the analysis of saltpetre.

[55] A. G. Werner, *Von der ausserlichen Kennzeichen der Fossilien*, Leipzig, 1774.

Guyton encouraged Madame Picardet to translate Werner's book, but it was not until 1790 that it appeared, with notes by Guyton, as the *Traité des caractères extérieures des fossiles*[56]. Guyton realized, with Bergman, that a mineral was completely described only when its chemical composition was known as well as its appearance, and he devised a portable set of apparatus for analysis in the field[57]. He also wanted to see a reform of the nomenclature of minerals, but did not himself attempt this task.

In 1789 Guyton, then aged fifty-two, enjoyed an international reputation as a chemist, but his scientific career was sharply interrupted by the French Revolution. In August, 1789, he became president of the patriotic club in Dijon, and the next year he was appointed to an important legal post, which he retained until August 1791, when he was elected to the Legislative Assembly in Paris. A year later he was again returned as a deputy to the National Convention, which declared France a republic on 21 September, 1792. When Louis XVI was tried by the Convention in January, 1793, Guyton was one of the majority who voted for his execution, and against the proposal to hold a referendum, maintaining that the Convention represented the people and expressed their will. He did not speak in the debate, but his opinion was published[58].

On 3 January, 1793, Guyton became secretary of the new Committee of General Defence, and was twice its president. This Committee was intended to co-ordinate the work of all the committees of the Convention, but with twenty-five members it was too large, and on 6 April the Committee of Public Safety, with only nine members, was founded. Guyton was its president from 6 April to 11 July, 1793, a period when most of its members were men of moderate opinions who tried to secure national unity during the critical days when the young republic, weakened by royalist revolts, was at war with half of Europe. But in July most of the moderates were swept away; Robespierre joined the committee on 28 July, and from that time it assumed far greater powers, which redeemed the military situation but led to the horrors of the Reign of Terror.

Guyton now concerned himself mainly with the applications of science to the national economy. In January, 1794, he was asked to analyse and test samples of foreign gunpowder, and he took part in artillery trials at Meudon and Vincennes, where he made the important invention of a new type of cannon-ball, which was cylindrical with a hemispherical head, and had a projecting ring

[56] *Traité des caractères extérieures des fossiles, traduit de l'allemand de M. A. G. Werner . . . par le traducteur des Mémoires de Chymie de Scheele*, 8vo, pp. xxx + (2) + 350, Dijon, *L. N. Frantin* and *Mailly*, and Paris, *Onfroy*, 1790 (BM, BN, FP). The approbation (p. xxx), signed by Guyton, is very complimentary to "Mme. P.***", the translator.

[57] *Nouv. Mém. Acad. Dijon*, 1783 (1st semestre), 159–76.

[58] *Opinion du citoyen L. B. Guyton . . . dans l'affaire de Louis Capet, dernier Roi des Français*, 8vo, pp. 27, Paris, *Imprimerie Nationale*, n.d. (BM, BN).

of lead at the base of the hemisphere. Iron or bronze cannonballs had to be slightly smaller than the gun-barrel to prevent binding, and this resulted in a loss of gas; but with the soft leaden ring the projectile could be made to fit tightly in the barrel, the loss of gas was eliminated, and the range increased[59].

There was at this time a very great demand for weapons and ammunition, and during February and March, 1794, four intensive "revolutionary courses" on saltpetre, gunpowder and cannon manufacture were given in Paris by the leading French chemists and engineers, including Guyton. The courses, each of which lasted only eight or nine days, were attended by men from all over France, who then returned to their own districts to spread and apply the knowledge they had acquired. Two editions of summaries of the lectures were printed, with the title *Mort aux Tyrans. Programmes des cours révolutionnaires*[60].

Guyton also resumed aerostatic experiments. He was one of the first to suggest the use of balloons in warfare, and on 26 June, 1794, he was present at the battle of Fleurus, in Belgium, when observers in a captive balloon, manned by the *Compagnie d'Aérostiers*, threw out messages with reports of the Austrian positions. These reports may have contributed to General Jourdain's great victory at Fleurus, and, on Guyton's recommendation, the Convention founded an *École d'Aérostation* at Meudon.

On 6 October, 1794, two months after the overthrow of Robespierre, Guyton entered the new Committee of Public Safety, which had very limited powers, and he left it on 3 February, 1795, the day after he had given to the Convention a long report on the state of the nation's armaments[61]. In August 1795, when France received a new form of government, the Directory, Guyton was elected on the Council of the Five Hundred. He did not play a very active part in its work, and he retired from politics in 1797. During his six

[59] *Mémoires de l'Institut*, 1807, 2nd semestre, 116–31.

[60] *Mort aux tyrans. Programmes des cours révolutionnaires sur la fabrication des salpêtres, des poudres et des canons. Faits à Paris, par ordre du Comité de Salut public, dans l'amphithéatre du Muséum d'histoire naturelle, et dans la salle des Electeurs, maison du ci-devant Evêché, les* 1, 11 *et* 21 *ventôse, deuxième année de la République Française une et indivisible; par les citoyens Guyton, Fourcroy, Dufourny, Bertholet* [*sic*], *Carny, Pluvinet, Monge, Hassenfratz et Perrier*, 4to. This title-page is followed by the printed summaries of fourteen lectures (eight on saltpetre and powder, and six on cannons), each of 2 or 4 pp., separately paginated (IF, S). The IF copy has a supplementary lecture, of 4 pp., which contains an account of the salts mentioned in the other lectures. There are other minor differences between the two copies.

The second edition is an octavo volume of pp. (ii) + 84, continuously paginated. The title is slightly modified to show that a fourth course was given, beginning on 5 Germinal, and is described as *Deuxième édition, à Paris, de l'Imprimerie du Comité de Salut Public, an 2 de la République Française* [BM: F.R. 287 (12)]. It includes the supplementary lecture on salts.

[61] *Rapport . . . par L. B. Guyton . . . sur l'état de situation des arsenaux et de l'armement des armées de terre et de mer de la République*, 8vo, pp. 27, Paris, *Imprimerie Nationale*, 1795 (BM, BN).

years in the various assemblies he had made speeches and presented reports on diverse topics[62], and served on many committees, including the important Committee of Public Instruction and the commissions for the revision of weights and measures and of the calendar.

There was a serious shortage of engineers in revolutionary France, and, to satisfy the needs of the large army and growing industries of the republic, the Convention founded in 1794 the *École Centrale des Travaux Publics*, which became famous under its later name, *École Polytechnique*. Guyton was one of the professors of chemistry from 1794 until his retirement in 1811, and was for a time the director of the college[63]. In 1795 he became one of the first members of the *Institut National des Sciences et des Arts*, which replaced the learned societies that had been suppressed in 1793. He made many technical reports to the *Institut*, and read memoirs describing research that he had carried out at the *École Polytechnique*, either alone or in collaboration with his assistants. Experiments in pyrometry occupied much of his time[64], and he continued the mineral analysis which had been a lifelong interest. There were several topics which, as in his Dijon days, he studied for a short time, sometimes obtaining useful results, but failed to develop. For example, he liquefied ammonia by passing the dry gas through a flask cooled to $-44°$ C, but he did not attempt the liquefaction of other gases.

Under Guyton's direction, Désormes and Clément investigated the reaction between zinc oxide and carbon, and showed, independently of Cruickshank, that the resulting inflammable gas was an oxide of carbon containing less oxygen than carbonic acid[65]. Less happy was the result of Guyton's study of diamond; after only one experiment he concluded that the combustion of diamond required more oxygen than that of charcoal, and that diamond was therefore pure carbon, and charcoal one of its lower oxides[66].

Guyton's most important publication in these final years was the *Traité des moyens de désinfecter l'air* (1801), a book dealing with a subject that had interested him for nearly thirty years. In February, 1773, part of Dijon was made uninhabitable by putrid emanations from bodies in the crypt of the church of St. Médard, and the authorities sought Guyton's advice. He knew

[62] Many of the speeches and reports were printed, and may be found in BM and BN.

[63] At the École Polytechnique practical chemistry was taught to large classes for the first time. An account of the courses of chemistry has been given by W. A. Smeaton, *Annals of Science*, 1954, **10**, 224–33.

[64] A long "Essai de Pyrométrie" was published by Guyton in three parts: Part 1, *Mém. de l'Inst.*, 1808 (2nd sem.), 1–35, summary in *Ann. de Chim.*, 1810, **73**, 254–62; Part 2, *Ann. de Chim.*, 1810, **74**, 18–46 and 129–52, and 1811, **78**, 73–85; Part 3, *Mém. de l'Inst.*, 1811 (Part 2), 89–120, reprinted in *Ann. de Chim.*, 1814, **90**, 113–37 and 225–38.

[65] *Ann. de Chim.*, 1801, **38**, 285–90 and **39**, 18–25; *J. École Poly.*, 1801–2, **4**, 322–6.

[66] *Ann. de Chim.*, 1799, **31**, 72–112. Guyton carried out other experiments on diamond; these were summarized in *Correspondance sur l'École Poly.*, 1813, **2**, 457–67.

that volatile alkali (ammonia) was sometimes evolved from decaying animal matter, and thought that this carried with it particles of unhealthy emanation. He also knew that marine acid fumes[67] caused the volatile alkali to be precipitated and concluded that the emanation would fall to the ground as soon as its supporting volatile alkali was removed. He therefore heated a mixture of common salt and oil of vitriol and left it overnight in the church; by the next morning the odour had gone and the district was again healthy. In December, 1773, he successfully repeated the process in the Dijon prison, where many prisoners had died[68]. Guyton's method was recommended for use in prisons by a commission of the Paris Academy of Sciences[69], and in 1794 the *Conseil de Santé* published an account of it at the request of the Convention, but it was not widely used at that time.

After hearing that Dr J. C. Smith had used nitric acid for fumigating ships of the Royal Navy, Guyton made a thorough examination of the subject, and in 1801 published his results and conclusions in the *Traité*[70]. He found that the gas evolved from putrefying meat did not always contain ammonia, and realized that his original theory was incorrect. All the mineral acids were found to remove the odour from the air, and Guyton now concluded that this action was due to the oxygen which all acids were then thought to contain. Muriatic acid was the most efficient because it was the most volatile acid, and Guyton considered that oxymuriatic acid (chlorine) should be even more effective, for not only was it more volatile than muriatic acid, but, according to the generally accepted theory, it was a compound of muriatic acid with excess oxygen. Tests showed that oxymuriatic acid was indeed more effective, and Guyton devised a simple apparatus for its production which could be used anywhere[71].

Guyton's treatise ran to a second[72] and third[73] edition, each enlarged, and it was translated into English[74], Dutch[75], Italian[76,77], German[78] and Spanish[79]. The process was widely used, and many accounts of its successful applications were published in *Annales de Chimie*. In recognition of this service to humanity,

[67] After 1782, marine acid was called muriatic acid; it is now called hydrochloric acid.

[68] *Obs. sur la Phys.*, 1773, **1**, 436 and 1774, **3**, 73.

[69] *Mém. Acad. Sci.*, 1780, 421.

[70] *Traité des moyens de désinfecter l'air, de prévenir la contagion, et d'en arrêter les progrès, par L. B. Guyton-Morveau*, 8vo, pp. xxxii + 304, Paris, *Bernard*, 1801 (FP, IF, PO, W).

[71] J. R. Partington (*Isis*, 1932–3, **18**, 191) has drawn attention to the incorrect statement that chlorine was used by Guyton in his original experiments in 1773 (A. Gilbert and P. Cornet, *Paris Médical*, 26 June, 1926; quoted in *Isis*, 1928, **11**, 196).

[72] *Traité . . .*, seconde édition, 8vo, pp. xlviii + 429, Paris, *Bernard*, 1802, with a portrait of Guyton facing the title-page (FP, IF, W).

[73] *Traité . . ., troisième édition, avec des planches et des additions considérables relatives surtout à la fièvre jaune*, 8vo, pp. xiv + 442, Paris, *Bernard*, 1805 (BN, FP, IF, LC, S).

[*Continued on next page.*

Guyton was admitted to the Legion of Honour in 1805, and in 1811 he became a Baron of the Empire.

In 1799 Guyton was appointed administrator of the mints, and occupied this post as well as his chair at the *École Polytechnique*. It cannot have been a sinecure, for in 1799 there were nine mints in France, and the number was later increased. He retained this post until the first Restoration, retiring on a pension in 1814, but returned during the Hundred Days and finally retired on 7 July, 1815.

He died on 2 January, 1816, and a short funeral oration was spoken by Berthollet[80], who referred only to his friend's scientific work, praising in particular the *Encyclopédie Méthodique* and the process for disinfecting the air.

I am pleased to thank the Central Research Fund of the University of London and the Centre National de la Recherche Scientifique for financial assistance, which enabled me to make several visits to France, and the staffs of all the libraries mentioned for their valuable co-operation. I am also grateful to Professor Douglas McKie for the encouragement and advice which he has given during the preparation of this paper.

[74] *A treatise on the means of purifying infected air, of preventing contagion and arresting its progress*, translated by R. Hall, 8vo, pp. xii + 248, London, *T. Hurst*, 1802 (SG).

[75] *Verhandeling over de middelen om de lucht te zuiveren, de besmetting te voorkomen, en der-zelver voortgang te stuiten; door L. B. Guyton-Morveau.* Translated by Prof. Pfaff Vermeerderd, with notes by A. van Stipriaan Luisçius, 8vo, pp. (8) + 232, Leyden, *A. and J. Honkoop*, 1802 (Univ. of Amsterdam). Another copy in the Univ. of Amsterdam has the imprint of *J. Hendriksen*, Rotterdam, but is otherwise identical with the first.

[76] *Preservativi contro la peste ossia l'arte di conservarsi in saluti, di prevenire il contagio, e di arrestare i progressi, col trattato dei mezzi di disinfettare e purgar l'aria, opera del famoso L. B. Guyton Morveau . . ., traduzione del francese, terza edizione*, 8vo, pp. xxxi + 128, Bologna, *Iacopo Marsigli*, 1804 (W). This is a translation of the *first* French edition (1801); two earlier editions of the translation evidently exist, but have not been located.

[77] *Tratto de' mezzi di disinfettare l'aria di prevenire il contagio e di arrestare i progressi, di L. B. Guyton-Morveau . . . traduzione del francese di Bernado Bianchino, Farmacista*, 8vo, pp. xii + 284, Venezia, *Francesco Andreola*, 1805 (W). This is a different translation of the first French edition. It also contains (pp. 247–79) a translation of the *Instruction* describing Guyton's process, which was issued in 1794 by the *Conseil de Santé*. The original French printing of the *Instruction* has not been located.

[78] *Abhandlung über die Mittel, die Luft zu reinigen, der Ansteckung zuvor zu kommen und die Fortschritte derselben zu hemmen . . . mit einigen Anmerkungen von Franz Heinrich Martens*, 8vo, pp. viii + 216, Weimar, 1802 (SG). Another German edition (pp. viii + 242) with notes by Martens, was published in Weimar in 1805 (Deutsche Staatsbibliothek, Berlin).

[79] *Tratado de los medios de desinficionar el ayre, precaver el contagio, y detener sus progresos, por L. B. Guyton-Morveau . . ., traducido por Don Antonio de la Cruz*, 8vo, pp. (10) + 294, Madrid, *Imprenta Real*, 1803 (Biblioteca Nacional, Madrid).

[80] C. L. Berthollet, *Funérailles de M. le Baron Guyton-Morveau*, Paris, 1816.

TANNING TECHNOLOGY IN ANCIENT MESOPOTAMIA[1]

By Martin Levey*

One of the most ancient arts in the technological history of mankind is the processing of skins and hides to manufacture furs and leather for shelter and clothing. By the time of the Sumerians, the possessors of the earliest literate civilization in Mesopotamia, leather was no longer the commonest material for clothing. We see the process of change in the Gilgamesh story, an ancient Sumerian epic, where the hero threw off his pelts to come to the city[2]. Ur, in the third millenium B.C., already possessed a thriving textile industry which was probably its most extensive and important manufacturing activity[3]. Leather, however, was widely used in ancient Sumer. Soldiers were provided with sole leather, leather scabbards and quivers. Leather was also used for the harness of oxen and donkey teams and for countless other objects. In the town of Girsu, in one year, 27 ox skins were used for cultic objects. Over one hundred sheep and goat skins were used at the same time.[4]

The Tanner, His Status and Work

The tanner was known in Sumerian as ^{lú}AŠGAB, in Akkadian as ^{amêl} aškappû[5]. These words usually occur as ideographs although we find the Akkadian spelled out for us in a text as ^{amêl} aš-ka-pi/pu[6]. In Aramaic, aškapu is related to 'eškāpā, 'uškāpā, and in Arabic 'iskāf[7]. The cuneiform sign for

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[2] R. C. Thompson, *The Epic of Gilgamesh*, Luzac, London, 1928, Tablet XI (Pl. 44–54), lines 249–253.

[3] T. Jacobsen, "On the Textile Industry at Ur under Ibbī-Sîn", Chapter in *Studia Orientalia Ioanni Pedersen*, Munksgaard, Hauniae, 1937, pp. 172–187.

[4] P. Deimel, "Übersicht uber die Keilschrift-Literatur", *Orientalia*, 27, 36 (1927).

[5] B. Meissner, "Studien zur Assyrischen Lexikographie", *Mitteilungen der Altorientalischen Gesellschaft*, II, part 1, p. 15 ff. (1937); F. Perles, "Splitter", *Orientalistische Literaturzeitung*, 14, 545 (1911); B. Meissner, "aškapu", *Orientalistische Literaturzeitung*, 14, 385 (1911).

[6] A. T. Clay, *Legal and Commercial Transactions . . . Nippur*, Univ. of Penna., Phila., 1908, Vol. I, Text 37:12; H. F. Lutz, *Selected Sumerian and Babylonian Texts*, Univ. Museum, Phila., 1919, Vol. II, Text 35:21.

[7] H. Zimmern, *Akkadische Fremdwörter*, Hinrichs, Leipzig, 1915, p. 28.

AŠGAB stems from a picture of a leather bag with a leather tube for discharge as is used to-day in the Orient for water and wine[8]. In Neo-Babylonian times, the word was often used as a personal name e.g. ^{lú}Ašgab^{ki} or ^{amêl} Aš-qu-up-pu and others[9,10,11]. In Seleucid texts, we find ^{amêl} risinnu as a tanner, from rasânnu, meaning to moisten or to take something into solution as "to soak (the hide in a special liquid)"[12].

Because of the unpleasant odour associated with tanning operations and also because of the custom of people in like trades working in the same section of the city, the tanners congregated in their own districts, ^{âl} (bît) (ša) ^{amêl} aškappê[13,14], "city of the leather workers"[15]. An economic document lists a total of seven fiefs on the bank of a canal which is in the city of leather workers. This was true also in the Talmudic period when the tanners were relegated to a district at a specified distance from the city because of the odour.

The leather workers probably had a number of occupational subdivisions. An example is that of the armour-leather craftsman, ^{amêl} aškapu si [-ri-ia-am][16]. Some of the leather workers made wagon parts[17], others tanned and made saddlery. There was also the KUŠ.SI(G).GA, a tanner who made furs or special leather products (KUŠ.SIG = "to beat", probably the hides)[18]. On the other hand, there were some workers who covered the entire range of leather work[19]. In a tablet of the first millenium B.C., the owner of a slave farms him out to learn "the entire craft of leather work". The tanner, with whom the agreement is made, is also a slave[20]. The apprentice agreed to "repair (all) the footwear of the house (family)"[21].

[8] P. Deimel, "Produkte der Viehzucht und ihre Weiterverarbeitung", *Orientalia*, O.S., 21, 39 (1926).

[9] J. N. Strassmaier, *Inschriften von Cyrus*, Pfeiffer, Leipzig, 1890, Text 164:8.

[10] J. N. Strassmaier, *Inschriften von Nabonidus*, Pfeiffer, Leipzig, 1889, Text 20:12.

[11] C. H. W. Johns, *Assyrian Deeds and Documents*, Deighton, Bell & Co., Cambridge, 1898–1923, Text 216: rev. 7.

[12] A. Leo Oppenheim, "The Material Culture of The Neobabylonian Period on the Basis of its Documents", unpublished manuscript.

[13] A. Tremayne, *Records from Erech*, Yale Univ. Press, New Haven, 1925, Texts 84:5; 109:4, 19; 194:18.

[14] A. T. Clay, *Business Documents of Murashu Sons of Nippur*, Univ. of Penna., Phila., 1912, Text 161:4, 6.

[15] H. V. Hilprecht and A. T. Clay, *Business Documents of Murashû Sons of Nippur*, Univ. of Penna., Phila., 1898, Texts 70:7; 97:4.

[16] A. H. Sayce, "Assyriological Notes, No. 2", *Proc. of Soc. of Biblical Archeology*, XIX, Text 71, col. II, 6 (1897).

[17] J. N. Strassmaier, *Nabonidus*, Text 1001:6.

[18] A. Leo Oppenheim, *op. cit.*, p. 172.

[19] J. N. Strassmaier, *Inschriften von Darius*, Pfeiffer, Leipzig, 1897, Text 457.

[20] A. Leo Oppenheim, *op. cit.*, p. 165.

[21] *Ibid.*, note 349.

It is thus seen from the last tablet quoted that leather craftsmen worked as slaves, although it is possible that some were freemen. Another tablet contains the agreement of sale of a "blind leather worker", [amèl] askappû ḫu-um-mu-ru[22]. In a list of food and drink rationed to various artisans, the leather workers received a slightly greater share than the average allowance for other craftsmen[23].

Types of Hides and Skins Utilized in Tanning

The ancient Mesopotamian tanners used a surprising variety of hides and skins. Sheep skins were used particularly for articles of clothing. The texts distinguished between sheep skins with shorn wool (KUŠ.UDU.SÌG.ŬR.RA) and skins with unshorn wool (KUŠ.UDU.BAR.GÁL.LA)[24,25]. Among the further types of sheep skins were the skin of a ram, lamb skin[26], and skin of a fat-tailed sheep[27]. The hides of the ox, grown steer and cow are mentioned in a list of hides brought in by people for the temple authorities[28,29,30]. Goat skins were known, as were young goat skins and small goat skins. In an old myth, the buffalo hide is mentioned[31]. An inventory lists a hide of a wild donkey. A medical text of about 2200 B.C. mentions the skin of a water snake[32]. This may or may not have been tanned.

Lexical lists indicate the use of an elaborate variety of skins and hides, e.g. field hog, spotted hog[33], wildcat, caracal, mongoose, surmulat, ibex, deer, shark, hyena, cat, rabbit, whelp, mouflon, wild boar, elephant, camel, wolf, lion, lioness, young lion, dog, tiger, panther, bison, jerboa, shrew, hamster and others[34].

[22] A. Tremayne, *op. cit.*, Text 144:7.

[23] A. Pohl, "Neubabylonische Rechtsurkunden", *Analecta Orientalia*, VIII, 26 (1933–4).

[24] P. Deimel, *op. cit.*, p. 37.

[25] W. Förtsch, "Religionsgeschichtliche Untersuchungen", *Mitt. d. Vorderasiatischen Gesellschaft*, XIX, 110 (1914).

[26] G. A. Reisner, *Tempelurkunden aus Telloh*, Spemann, Berlin, 1901, p. 42.

[27] ḪARRA-ḫubullum lexical list, XI, 1–70.

[28] See note 26.

[29] P. Deimel, *op. cit.*, pp. 27–40.

[30] D. W. Myhrman, *Sumerian Administrative Documents*, Univ. of Penna., Phila., 1910, p. 65.

[31] *Cuneiform Texts in the British Museum*, British Museum, London, 1902, XV, Text 1, col. 2.

[32] M. Levey, "Ancient Chemical Technology in a Sumerian Medical Tablet", *J. Chem. Educ.*, 32, 11–13 (1955).

[33] *Cuneiform Texts in the British Museum*, 1902, XIV, Pl. 49, rev.

[34] *Harra*, XI, 1–70.

Skin and Hide Products

Leather was employed for many purposes in every walk and aspect of ancient life[35]. It was used (inflated) for a small boat or raft[36,37], door hinge, cuirasse[38], bag for drinking water, pouch for milk, oil, fat or salt[39], butter and honey bag[40,41], barber's and doctor's bag, knife and stylus case[42], pouch to hang on one's neck as an amulet[43], lash[44], armour[45], helmet, shield, quiver, saddle, harness[46], casing of a pommel bag[47], tube[48], (sounding), skin of the ape (= drum?)[49]. Shoes, sandals and belts were made of leather[50,51]. Shoes were often made very elaborately, such as those sent by Tuschratta of Mitanni to his father-in-law Amenophis III in Egypt[52], replete with textile and metallic decoration.

In the first millenium B.C., the Assyrians possessed the knowledge of making parchment. Parchment, ni'âru[53,54], was used mainly for Aramaic cursive writing[55]. The parchment scribe was called ^{amêl} kussarû[56] and the skin or

[35] P. Deimel, *op. cit.*, p. 38.

[36] L. Legrain, *Ur Excavations Texts III Business Documents of the Third Dynasty of Ur*, Univ. Museum, Phila., 1947, Text 830.

[37] M. I. Hussey, *Sumerian Tablets in the Harvard Semitic Museum*, Harvard Univ. Press, Cambridge, 1915, Text 2:52.

[38] O. Schroeder, "Die Tontafeln von El Amarna", *Vorderasiatische Schriftdenkmäler*, XII, Text 199, col. III, 38 (1915).

[39] *Harra*, XI, 198–201; *Harra*, XI, Gap C, 189 ff.

[40] B. Landsberger, "Zu den Übersetzungen Ebeling's ZDMG 74, 175 ff.", *Zeit. d. Deutchen Morgenländischen Gesellschaft*, LXXIV, 445 (1920).

[41] T. Jacobsen, *Cuneiform Texts in the National Museum, Copenhagen*, E. J. Brill, Leiden, 1939, p. 60.

[42] *Harra*, XI.

[43] E. Ebeling, "Keilschrifttexte aus Assur Religiösen Inhalts", *Wissenschaftliche Veröffentlichung der Deutschen Orient-Gesellschaft*, Text 56, rev. 13.

[44] A. Deimel, *Codex Hammurabi*,Pontificium Institutum Biblicum, Rome, 1950, § 202.

[45] *Harra*, XI, 280.

[46] P. Jensen, "Assyrisch-Babylonisch Mythen und Epen", *Keilinschriftliche Bibliothek*, VI, 1, 170 (1900).

[47] *Harra*, XI, 281.

[48] *Proto-diri lexical text*, 584.

[49] *Harra*, XI, 270.

[50] V. Scheil, "Vocabulaire Pratique", *Revue D'assyriologie*, XVIII, col. 7, 32–43 (1921).

[51] T. Fish, "New Harvard KUŠ Texts", *Manchester Cuneiform Studies*, I, no. 4, 50–55 (1951).

[52] J. A. Knudtzon, *Die El Amarna Tafeln*, Hinrichs, Leipzig, 1915, part II, pp. 164, 23 ff.

[53] R. F. Harper, *Assyrian and Babylonian Letters Belonging to the Kouyunjik Collection of the British Museum*, Luzac, London, 1897, Text 568, rev. 19; E. G. Klauber, *Politisch-religiöse Texte aus der Sargonidenzeit*, Pfeiffer, Leipzig, 1913, Text 49:4.

[54] H. Zimmern, *op. cit.*, p. 19.

[55] B. Meissner, *Babylonien und Assyrien*, Winters, Heidelberg, 1920, Vol. I, p. 259.

[56] A. T. Clay, *Babylonian Records in the Library of J. Pierpont Morgan*, Yale Univ. Press, New Haven, 1912, Vol. II, Text 31:3.

hide for this purpose, [mašak] na-a-a-ru[57,58]. A late tablet describes the receipt for the delivery of a parchment (?) hide for scribes[59].

There is no Assyrian record as to the method of preparing skins for parchment but the Talmud relates that, among other steps, the hide was treated with lime and smoothed either on one side or on both. The latter type was employed for important religious works. The former, which was made from the diphthera skin, was much cheaper and was used only on one side. Only skins and hides of certain animals were utilized[60].

Curing, Soaking, Depilation and Bating

The first step was to flay the slaughtered animal to obtain the new hide ([mašak] ši-iḫ-ṭu)[61]. In a lexical list, the stripped-off skin is called KUŠ.BAR pa-ar-ri[62]. In a letter, we read "The sheep which have a disease of the mouth, which are not strong, let them slaughter and remove the hides from the bodies . . .". The hides were thus an important economic item[63]. In a historical account of Assurnasirpal, we read "I flayed [the enemy] in the city of Arbela and I spread his skin upon the city wall"[64]. The skin probably was spread to putrefy in the hot sun, this, evidently, not being the usual custom.

Immediately after flaying, the fresh skins were cured. They were probably soaked in water or in a solution containing native saline earth. The skins were then scoured and later pounded to remove most of the inner flesh and fat with a fleshing knife. If this had not been done, it would have been unwise to have had skins stored in the warehouse.

The flayed skins which had undergone preliminary treatment must have been stored before the tanner was ready to work on them. Some evidence for this is in a text which differentiates between old and fresh hides. These fresh hides are called KUŠ.GABA.BIL[65] in Sumerian and in Akk. [mašku] bal-ti-nar-bi. The fresh hides were delivered to the tanner, in a text[66] reading

[57] R. P. Dougherty, *Archives from Erech*, Yale Univ. Press, New Haven, 1923, Vol. I, Text 54 : 9.

[58] *Ibid.*, Text 92 : 5.

[59] E. Ebeling, "Keilschrifttexte aus Assur verschiedenen Inhalts", *Wissenschaftliche Veröffentlichung der Deutschen Orient-Gesellschaft*, XXXV, 76 (1920).

[60] S. Krauss, *Talmudische Archäologie*, Fock, Leipzig, 1911, Vol. II, p. 263.

[61] A. Leo Oppenheim, *op. cit.*, p. 159.

[62] *Harra*, XI, 272.

[63] R. F. Harper, *op. cit.*, Text 75, rev. 1–4.

[64] E. A. W. Budge and L. W. King, *Annals of the kings of Assyria*, British Museum, London, 1902, p. 277, line 68.

[65] M. V. Nikolskii, *Dokumenty khoziaistvennoi otchetnosti*, Uvarov, Petersburg, 1908, Text 232.

[66] J. N. Strassmaier, *Nabonidus*, Text 345 : 1–5.

"1100 ši-ḫa-ṭu" (i.e. flayed skins) which are from the warehouse are [at the dispo]sal of the tanner[67].

When the hair of the hide was undesirable, the flayed skin was left to putrefy to a limited degree. In primitive cultures, this is done by immersion in urine followed by scraping with a blunt knife to remove the epidermis and roots. A text mentions "1½ putrefied ox-hides"[68]. This was probably done by simply soaking in water to allow the bacteria on the skin to act in the depilation process. The nature and kind of soaking would vary with such factors as the type of leather to be obtained, the nature and condition of the skin and with the subsequent process[69]. We are in doubt as to whether any substance was added to the steeping water. This unknown also presents itself in a Middle Babylonian text which reads: (a shepherd taking care of the sheep) "will steep all the hides (of the deceased animals)"[70]. This was to prevent undue putrefaction and ensure preservation of the hides for the tanner. Possibly, the hides were immersed in a salt solution after partial dehydration in air. The hide undergoing this treatment is known as flint or flint-dried. This would then be the curing stage in which degenerative changes due to bacteria on the skin would be arrested.

Depilation may be considered to have been carried out as a natural bacterial process, since there is no evidence that any particular substance was used to assist in this operation. However, after the bacteria began the process of depilation, the mechanical process of removing the flesh, fat and surface muscles in addition to the hair and epidermis required certain tools. In this connexion, a text reads, "2 sharp tools (of wood) tar-mi-it (?), of which 1 is new, 1 kisirru (?) at the disposal of Nidintu, the leather worker. . ."[71]. Another possibility is the use of a "stone of the leather worker", abnu ša ^{amêl} aškappi[72].

The next step after depilation is the bating process in which, as we know it to-day, proteolytic enzymes act upon a hide or skin to reduce its swollen state and to produce other beneficial but still unknown physical and chemical changes. Without bating, no fine leather may be made. This is the treatment

[67] A. Leo Oppenheim, *op. cit.*, note 345.

[68] T. Jacobsen, *op. cit.*, p. 65.

[69] G. D. McLaughlin, *The Chemistry of Leather Manufacture*, Reinhold, New York, 1945, p. 158.

[70] A. T. Clay, *Documents from the Temple Archives of Nippur*, Univ. of Penna., Phila., 1906, Text 48:17.

[71] A. Ungnad, *Vorderasiatische Schriftdenkmäler*, Hinrich, Leipzig, 1908, Vol. VI, Text 219:1–5.

[72] Oppenheim believes that this instrument was probably for beating the hide. In this connection we have an interesting name for a man, ^{lú}KUŠ.TAG.GA (J. N. Strassmaier, *Zeit. f. Assyr.*, IV, 14), explained in a syllabary as ^{amêl}e-piš ip-qi-da-a, meaning "a hide beater".

with a dung infusion. Without doubt, it was this stage of the tanning operations which was the main cause of the leather workers living in their own towns. Pounding and rubbing at this time assist in preparing the skins for tanning.

Tanning Operations

The next step was the actual tanning itself. The two oldest tanning methods are (1) tawing and (2) the oil process. Based primarily on evidence from contemporary primitive peoples, the latter process may be considered to be the oldest.

The ancient Mesopotamian literature reveals that vegetable tannins were used with a mineral agent in the same solution. There were a number of variations in this operation. For this steeping process, the A.GAR (waterpit) was used, as "3 hog-skins brought from the A.GAR"[73,74]. Also we find the line, ^{kuš} A.GAR.KAGÀ.GÀ.DÉ NN šu-ba-ti, "to put the sheep skin in the waterpit NN received"[75].

A method still in use in the Near East seems to have been practised in ancient Mesopotamia. This is the technique of filling the skin or hide in the form of a bag with the tanning solution and throwing the filled skin or hide into a tanning vat. Evidence for this comes from two tablets. In one we read "400 sheep skins, leather containers, steeped in water and puffed up"[75]. In this case, by water is meant an aqueous solution containing one or more solutes, since we have the same meaning in an ancient Sumerian pharmaceutical table[76]. In another document we read "9½ skins for inflation Innin-zêriddina, son of Zêria, has received, the 12th day of Iyyar, the 3rd year of Nabonidus, king of Babylon"[77]. Bezold gives mašku duššu, here translated as "skins for inflation", as "aufgeschwalter Balg"[78].

A tablet of the first millenium B.C. lists alum, gall nut and myrrh as tanners' materials. Probably the extract of the gall nut, the tannin, is meant.

> ". . . mina 6 shekels of alum
> . . . mina gall nuts
> 1/3 qa of fat, 1/3 mina and 2 shekels of myrrh
> for tanning
> 11th day of the month of Aiaru
> to Kiminai, the leather worker, has been delivered . . ."[79].

[73] M. V. Nikolskii, *op. cit.*, p. 243.

[74] *Ibid.*, p. 241.

[75] T. Jacobsen, *op. cit.*, p. 69, Text 17:1–2.

[76] M. Levey, *op. cit.*

[77] E. W. Moore, *Neo-Babylonian business and administrative documents*, Univ. of Michigan Press, Ann Arbor, 1935, Text 34:1 ff.

[78] E. Ebeling, "Neubabylonische Briefe aus Uruk", *Beiträge z. keilschriftforschung und religionsgeschichte des vordern Orients*, 1–4 (1930–34).

[79] J. N. Strassmaier, *Inschriften von Cambyses*, Pfeiffer, Leipzig, 1890, Text 155.

The fragment of a ritual describes the sacrifice of bulls whose hides were destined to be stretched on the kettle drum which accompanies the kalu in chanting his lamentations[80].

"You take this hide and steep it in pulverized flour of pure wheat in aqueous mixture, fine wine (and then) rub it with fine fat of a pure bullock, alum of the Hittite country and gall nuts. Then you will spread it over the brass kettle-drum"[81].

A parallel text reads:

"You will take the hide of this bullock and in pulverized flour of pure wheat, in aqueous mixture with the best beer and in wine, you will soak it. In the fat of a pure bullock and extracts of aromatic (plants), 4 qa of malt flour, 4 qa of bit-qu flour, 1 qa of satru (or kur-ru) flour, you will steep it. You will rub it with gall nuts and alum of the Hittite country"[82].

A magical text mentions the treatment of a skin of a small goat describing the tanning operations:

"You will steep the skin of a young goat with milk of a yellow goat and with flour. You grease with fine oil, ordinary oil and fat of a pure cow. You will soak the alum in grape juice and cover the surface of the skin with gall nuts of the arboricultivators of the Hittite country"[83].

The ritual texts, although written down in the first millenium B.C., probably stem from a very early date and perhaps reflect a technique dating back to the third millenium or earlier. The tanning materials mentioned in these texts were placed in one mixture in which the skin or hide was steeped. This procedure is still followed to-day in the region of Baghdad[84]. Flour, as well as alcoholic liquids, was also used as described in the ritual texts.

The magical text is interesting in that it makes full use of oil in the tanning process although it does not omit the use of alum and gall nuts. It would therefore seem to be a combined series of operations making use of two different tanning techniques. Evidently, the magical text had its origin in very early times but was amended in later times.

The ancients denoted leather as "tanned" [KUŠ.AL.K]Ú.E, [ak-l] u or "untanned" [KUŠ.NU].AL.KÚ.E [la ak-lu][85,86]. There is some question as to whether the tanned leather was split. A lexical text does, however, give a

[80] F. Thureau-Dangin, "Notes Assyriologiques", *Revue d'Assyriologie*, 17, 27–30 (1920).

[81] E. Ebeling, *Keilschrifttexte aus Assur, religiösen Inhalts*, Text 60, rev. 5–8.

[82] F. Thureau-Dangin, "Le Rituel du Kalû", *Revue d'Assyriologie*, 17, 56 (1930), Tablet AO 6479, col. II, 21–24.

[83] F. Thureau-Dangin, *Revue d'Assyriologie*, 17, 29.

[84] F. Thureau-Dangin, *op. cit.*, 30.

[85] *Harra*, XI, Gap. B, a3, a4.

[86] P. Deimel, *Orientalia*, 21, 39 (1926).

term for split leather as KUŠ.SÙ.GA, šip-ku[87]. Also, there is a term for "thick or swollen leather", maśku sabyútum[88], related to hides defined by AGAR. NAG.A", steeped, sated" (NAG = drink) to indicate swelling.

Tanning Materials

Fat of a pure bullock, fine oil and ordinary oil were known in the tanning of skins and hides. It is rather surprising that in the oil-rich Near East, tanning with oil was not mentioned in the Talmud[89]. Oil tannage consists simply of oiling or greasing the skin when it is wet, then kneading and stretching it as it slowly loses moisture and absorbs the fat. The process is still in use to-day to make the finest furs by treading with oxidizable oils. Another example of the oil tanning method in modern times is "chamoising" in the manufacture of wash-leathers[90].

One of the ritual texts employs aromatic extracts of botanicals without naming the plants. A Neo-Babylonian tablet reads "22 shekels of myrrh from the warehouse for tanning."[91] Myrrh would act as a counteractant to the foul smells present in the tanneries.

Alum, a mordant in the dyeing of cloth and much used in pharmacy, was widely employed in the tanning of leather. Alum, ^{aban} gabú or in Sum. IM.SAḪAR.NA$_4$.KUR.RA[92] was obtained from Egypt[93] and from a country called ka-šap-pu[94]. Tanning with alum alone, a combination of alum with collagen, is called tawing to differentiate it from the stable tanning action of various other salts or vegetable tannins. The aluminium salt absorbed by the fibres hydrolyses very easily, indicating that the hides are incompletely tanned by this process. These unstable hides may, however, be retanned[91].

It is of interest that, in the ancient Mesopotamian tablets, alum is never found to be used alone. It is usually employed in conjunction with another tanning agent. Hides tanned with alum alone have no suppleness and are not very useful for most purposes. If salt or sodium sulphate were to be used with the aluminium salt, a much better product is produced, since acid swelling is repressed and a higher pH is obtained without precipitation. Alum, in ancient times, was probably almost always contaminated with ferric salts which would, of course, tan. The quantity of ferric ion impurity would then

[87] *Harra*, XI, 283.

[88] I. J. Gelb, *Inscriptions from Alishar and Vicinity*, Univ. of Chicago, Chicago, 1935, Text 55 : 18, note p. 57.

[89] S. Krauss, *op. cit.*, p. 261.

[90] H. R. Procter, *The Principles of Leather Manufacture*, Spon, London, 1922, p. 457.

[91] G. D. McLaughlin, *op. cit.*, p. 656.

[92] *Harra*, XI.

[93] J. N. Strassmaier, *Nabonidus*, Text 751 : 7–8.

[94] A. T. Clay, *Neo-Babylonian Letters from Erech*, Yale Univ. Press, New Haven, 1919, Text 14 : 8–9.

determine the permanency of the tanning. The Talmud informs us that salt solution with alum was in use in those times. This makes an excellent tanning vehicle completely different in properties from a solution containing only alum[95].

It was by empirical methods that the ancient Mesopotamian found that some form of tannin was necessary to make a longer lasting leather. The texts quoted above show the use of the gall nut (most likely only its extract). The gall nut, ^{is} ḫu-ra-tu, in Sum. ^{giš}RIN, ^{šim}RIN, produces a particularly rich tannin and is very abundant in Asia Minor. In Sargon's time, about Harran, the oak was very plentiful. These may have been grown with the galls in mind since they yield as much as 50–60% tannin. The oak bark was also probably known as a tanning agent, although we do not identify it as yet in the literature. The gall nut appears in a lexical list of vegetables or parts of vegetables[96]. In the Cambysus Text 155, quoted above, it appears side by side with alum. It is found in similar position in a tablet containing a record of expenditures[97]. Galls were also used for the surface of kelek skins which buoy up the rafts. Pomegranate rinds, also rich in tannin, may also be used for this purpose[98].

A tablet from Carchemish, which tells us something of the tanning trade, mentions sumach among other tanning agents[99].

". . . In the village of Elumu all of it, the depot (?), their underlings as well as their overseer(s), after the tanning-bark (?) on the royal estate, on field, house, and park has been stripped, [he] will provide the villages with tannin (?). If there is leather working (if it is good) [the villages] are to draw (?) [on the tannin (?)] throughout the villages all the ap-ḳi (?)-men, as well as their children, [he] will provide from (?) all the depots (?).

The alhagi which is full of juice (?) . . . therein their fathers, their grandfathers in the presence of S., the alhagi in the midst of their oak trees, in the midst of their sumachs (:) S. will provide. Shoemaker, . . . -man . . .".

From the text, the oak and sumach are the two principal sources of tanning agents. The translation, it must be remembered, is highly uncertain.

^{šam} šuḫtu, according to Thompson, is copper acetate used by the leather workers since it is found as ^{šam}kamme aškapi, "the ^{šam} kamme "of the tanners or leather workers". Šuḫtu and kamme are equated in a lexical tablet[100]; but their meaning is uncertain. Thompson's interpretation, however, is highly

[95] S. Krauss, *op. cit.*, p. 261.

[96] *Harra*, VI, 53.

[97] E. W. Moore, *op. cit.*, Vol. I, Text 42 : 8–9.

[98] A. H. Layard, *Ninevah and its Remains*, Murray, London, 1849, Vol. II, p. 98.

[99] R. C. Thompson, "The Cuneiform Tablet from House D" in C. L. Woolley, *Carchemish*, British Museum, London, 1921, Vol. II, pp. 141 ff.

[100] R. C. Thompson, *A Dictionary of Assyrian Botany*, British Academy, London, 1949, pp. 169, 170.

doubtful and may not be relied upon. It is, nevertheless, some substance used by the leather workers.

Flour of wheat and malt were used in the Akkadian texts as quoted above. A tablet attests to the use of flour in tanning, "flour for sat-ru of the tanner"[101]. In the Talmud, skins and hides were often treated with flour and gall nut powder. This produced the so-called sour-hide[102]. When treated with salt and flour but not with gall, the skin was called diphthera. Two other main types of skin, classified according to the processes used, were the unsoured hide—untanned and not treated with salt or flour and finally the skin steeped in salt but not in flour or gall solution. A fifth skin is also mentioned. This was liquored in gall and salt solution[103].

In a Harvard Semitic Museum text we read "10 sheep skins, wool shaved off; the skin is with 2-ul X (perhaps a tanning substance) wetted". The last word is dar-ri-dé, still unknown[104].

Dyeing of Leather

The ancient Mesopotamians often dyed their leather. We read "1 leather (?) for a bow, dyed . . ."[105]. Also, "8 steeped skins of sheep, 5 dyed, 1 dušû leather from the ooze"[106]. In a tablet whose context comes from an early date, we read "The dyer (?) had not dyed his leather with it (?)[107]. Another tablet mentions the dyeing of large goat skins to a dark shade[108]. Five sheep skins dyed red and one dyed dark are mentioned to be sent in an Assyrian tablet[109]. Black and white hides occur in an old Sumerian leather tablet.

The dyer was called ^{amêl} ṣa-rip[112] and the dyer whose speciality was dušû leather[110] was called ^{amêl} ṣarip dušê. This was a soft, coloured leather used for parts of a horse harness[111]. Probably the dušû colour was that of the stone

[101] A. Leo Oppenheim, *op. cit.*, note 352.

[102] S. Krauss, *op. cit.*, p. 261.

[103] *Ibid.*, p. 262.

[104] M. I. Hussey, *op. cit.*, Vol. I, p. 45, Pl. I, II.

[105] A. T. Clay, *Business Documents of Murashu Sons of Nippur*, Univ. Museum, Phila., 1912, Text 2:54.

[106] A. T. Clay, *Neo-Babylonian Letters from Erech*, Text 195:4–6.

[107] C. J. Gadd, "Epic of Gilgamesh Tablet XII", *Revue d'Assyriologie*, 30, 130 (1933).

[108] E. Ebeling, "Neubabylonische Briefe", Text 226:22 from C. E. Keiser, *Letters and Contracts from Erech Written in the Neo-Babylonian Period*, Yale Univ. Press, New Haven, 1917, Tablet K26:17–22.

[109] A. T. Clay, *op. cit.*, Text 196:4–7.

[110] H. C. Rawlinson, *Cuneiform Inscriptions of Western Asia*, British Museum, London, 1866, Vol. II, Text 31:76b.

[111] A. Leo Oppenheim, *op. cit.*, p. 170.

[112] C. E. Keiser, *op. cit.*, Text 26:18–22.

of the same name, a bright yellow or green[113]. There were probably other colours for dyeing. In the Talmud, leather was dyed black with vitriol. It was also dyed red, green, white and purple[114]. It is uncertain whether the Mesopotamians possessed vitriol before Talmudic times.

Evolution of Tanning Technology

In primitive technology, only oil tannage is known. This was true of the Stone Age man and also of the Eskimos in the Far North. In the ritual texts quoted above, it may be seen that not only was oil used but also alum and gall nut tannin. Most of the content of these texts goes back, probably, to early historic or late prehistoric times when oil tannage was better known. It must have been shortly after that the texts were altered somewhat to include later technological knowledge. However, in the Cambysus text, a document of the first millenium B.C., we see that no oil was used but only alum, tannin and myrrh.

Tanning Technology, An Ancient Art

Tanning technology, in ancient Mesopotamia, showed progress until the Neo-Babylonian period. The use of leather products penetrated into every phase of Mesopotamian life. Although we do not have conclusive evidence, it is likely that the techniques used were highly specialized for the various types of leather manufactured. Unfortunately, leather could not withstand the ravages of the climate in Mesopotamia to allow us to prove the point by chemical analyses of the artifacts.

Nevertheless, there is some evidence, however slight, that not all skins and hides were expertly treated. A medical tablet of the first millenium B.C. reads, "rust (šuḫtu) of . . . on a hide"[115]. This word is similar to Syriac šuḫtā, Mand. šūtā, "tarnish (?) of gold"[116]. It is possible that this was the word for spue, an exudation of a substance once in the leather which has then come to the surface by chemical or physical means. Spue is usually some type of fatty acid, although inorganic salts may also spue.

Few of the important modern phases of tanning technology have come into use because of scientific research as we know it to-day. Rather, the major tanning operations have come about as a slow empirical development from prehistoric times, through the ancient Mesopotamian period down through various stages to modern times as a connected and developing stream of knowledge. The evolutionary thread in this area of our technological development runs parallel to the line of blossoming of our cultural traditions in other fields.

[113] See note 111.

[114] S. Krauss, *op. cit.*, p. 263.

[115] R. C. Thompson, *Assyrian Medical Texts*, Oxford Univ. Press, London, 1923, Text 12, 8.

[116] R. C. Thompson, *Dictionary of Assyrian Chemistry and Geology*, Oxford Univ. Press, Oxford, 1936, pp. 63, 71.

REVIEWS

Mysterium Coniunctionis. By C. G. JUNG. Unter Mitarbeit von Dr.phil. M.-L. v. Franz. Vol. I, 1955. Pp. 284; Vol. II, 1956. Pp. 418; Vol. III; sub-title: Aurora Consurgens. By Dr M.-L. v. FRANZ. 1957. Pp. 480. Zurich; Rascher Verlag.

PROFESSOR JUNG has given us the key to the interpretation of dreams and has attempted, subjectively, it is true, to interpret these dreams and their contents, the contents being regarded not merely as phantasies, but as reflections of certain archetypal symbols which compose the human "psyche". "Psyche" might be used here as a term to include the whole working mechanism of what is now called the subconscious, with its effects on the conscious level of the mind. The clinical approach to psycho-analysis has led Professor Jung to a study of dream-symbolism as something more than a possibility of unlimited therapeutic research; he discovered, rightly or wrongly, a great similarity between certain dreams he had encountered in his practice, with the symbols used by the alchemists. By reading and studying almost every available alchemical text —and let it be said here that it is the first time in the long history of alchemy that a single person and his associates have read so many texts—a fact of the highest importance with reference to the work under review—Professor Jung has come to certain conclusions, which have resulted in his production of the above book.

We have here for the first time a sincere attempt to interpret the obscure language of the alchemists. By reading innumerable texts, by means of cross-references and the careful study of the old alchemical lexicons, Professor Jung has, certainly more than any modern scholar, "contacted" the minds of the alchemists and the method of their logic; for the alchemists *were* logical and through the centuries did their best to erect an edifice of what can be called to-day "parapsychology"; but it is more than what we mean by this modern word, which is still in its technical infancy. The alchemists attempted by psycho-physical means to lead the soul—and the body—to a higher state of existence, to a sense of awareness beyond that which is given to the ordinary individual during the span of his earthly life. Professor Jung has given us a lexicon of alchemical terminology, more profound and more exact than the purely literary approach to the subject can ever give us. On this basis it is possible to examine Professor Jung's thesis as to what are the fundamental problems of alchemy. No attempt is made to include the purely metallurgical aspect of the subject, which is looked upon as a concurrent physical phenomenon. Perhaps, it can be argued, the metallurgical results have not been sufficiently emphasized, but that criticism would be beyond the point here. Alchemy was undoubtedly a religious system that developed parallel with the Christian Church, and it is most interesting in this work to read about the attempts of the alchemists to adapt themselves to the symbolism and the faith of the Christian Church, while, on the other hand, the theologians are coming to terms with alchemy. Indeed, the third volume, the "Aurora Consurgens", gives us a remarkable picture of the state of mind in which alchemy and

Christianity permeate each other. The text was written probably by a churchman of the 13th century; he uses the mysticism of the Song of Songs as a basis on which Christian ideology can be united with the heterogeneous philosophy of nature of the alchemist and the result is a hymn of praise to God and to alchemy.

According to Professor Jung, the main theme of the alchemical process is the conjunction. What the adept sought was the union of substances. The aim of the Great Work was to produce gold or a *symbolical equivalent* as a result of this union. However, the alchemist did not think in concrete terms as do the modern philosophers and scientists; his terms were personal in their attribution, for example, iron was Mars, copper was Venus, and therefore the act of union was regarded as a personal union, as a "union of love" in those texts that deal with the more metaphysical and purely religious aspect of alchemy, and by the latter we also mean some of the Grail romances, which are the literary expressions of a purely personal aspect of this religion of coalescence. To quote Professor Jung: "the union of 'Natures' that 'embrace' each other is not meant to be merely a physical and concrete union, because they are the 'naturae coelestes' that multiply themselves 'nutu Dei'. For instance, when 'red lead' is roasted together with gold the result is a 'spirit'; that is, the union of the metals has become 'spiritualized', it has produced the 'red spirit' out of which comes forth the 'mundi principium' ". We think of the fusion of metals as an amalgam, but for the alchemists it has become—in the case, for instance, of the union of copper and Aqua permanens (this is usually meant to be mercury)—a mysterious philosophic sea, a symbol of a more concrete philosophical reality which they hoped to find, or to have discovered, in the different "fluids". The word "fluid" is used here in the alchemical sense, as an abstraction, but at the same time it can become a tangible fluidic matter for the alchemist as the process of the Great Work unfolds.

The substances which the alchemist attempted to unite, experimenting in his own fashion, always had a more or less "numinous quality", to quote Professor Jung again, and this pointed towards a "spiritual personification" of these substances. The reason for this "personification" seems to have been the ignorance in former centuries of the physical components of different aspects of matter, or, it might be added, the indifference to a purely physical interest in matter as such. The substances "fertilized each other, as if they were living beings, and thus created that living entity—which the Greeks called ζῶον—which it was the aim of the "philosophers" to find. The substances were thought of by the alchemists as having an hermaphroditic nature—the origin of this assumption can be found in the world of ideas which Professor Eliade calls "the world of archaic man"—and the conjunction which they tried to produce was a "philosophic operation", the union of form and matter, not only a union of two different forms of matter. This is important to remember because it is the direct cause of the many attributes given to each particular substance and of the multiplication of the substances themselves. For instance, there are two mercuries, two sulphurs; there is a Venus alba and a Venus rubea, an aurum nostrum and an aurum vulgi. The alchemists used a great number of synonyms to describe the mysterious nature of the substances. As Professor Jung says, all "contents of a numinous character have a tendency towards self-amplification, they form the nuclei for innumerable synonyms". This explanation of alchemical terminology is profound, and

will take the student a long way towards a more precise appreciation of what the alchemists tried to do.

An example of what the alchemists were aiming at by their use of synonyms in order to produce *the* substance, which was the object of all their labours, can be found in a text taken from the Musaeum Hermeticum, 1678, entitled "De Sulphure". The translation is as follows:

> "Thus Fire began to work upon Air and brought forth Sulphur. Thereupon Air began to work upon Water and brought forth Mercurius. Water began to work upon Earth and brought forth Salt. Earth, however, could not work upon anything as nothing was contained in Earth and so the 'product' remained in her. Therefore there are only three principles (i.e. Sulphur, Mercury and Salt) and the Earth became the nurse and the mother of the others (i.e. the other 'products' of the Earth as opposed to 'principles')".

According to Professor Jung's interpretation of this passage, the Male and the Female emerged out of these three principles: the former out of Sulphur and Mercury, the latter out of Mercury and salt. However, the Male and the Female produce the "one that is indestructible", the "unum incorruptible", the "Quinta Essentia", and thus, so continues the "De Sulphure", "the Square corresponds to the Square".

According to the "axiom of Maria" (the Egyptian alchemist and reputed friend of the Greek philosopher Democritus) the "Unum Incorruptible" is the synthesis of "Four"; that is, the three principles and the additional one which is represented by Earth. The hostile separation of the elements corresponds to the primal state, to chaos, to darkness. Out of the successive union (of the elements) emerge an active agent (Sulphur), a passive agent (Salt) and an ambivalent force, Mercury, and it follows according to the alchemical reasoning that this Trinity, a fundamental conception of the alchemical state of mind, causes to emerge the relation of the Male and the Female agents as the supreme and essential antithesis. Fire, produced without a cause, is at the beginning, and Earth, which does not bring forth anything of a fundamental causative quality, is at the end of the alchemical sequence. There is no interaction between Fire and Earth, therefore the four principles do not form a circle, a whole, but they form a square. The circle—the whole—is formed from the synthesis of the male and female essences. The "square of the beginning", the relation of the four principles to one another, on the other hand, finally produces in the "Quinta Esentia", the "Unum Incorruptible" a "Quaternio of Four Elements"—that is, the four principles produced through the medium of the unifying agent (the Quinta Essentia), have now become "elements" in a sense approaching our modern definition of this term; they have become substantial agents. Therefore, in alchemical terminology, the four principles correspond to the "Quaternio of the Four Elements", which is symbolically expressed as "the Square corresponds to the Square".

The alchemists related this symbolism to the consciousness of the adept himself. The alchemical beginning of things corresponds to the primitive consciousness which is in a perpetual state of affective reactions and threatens to "fall apart", so to speak, in four directions. As the four elements represent the constituents of the physical world, their dissolution would mean a dissolution of the world, or, on the psychological plane, human consciousness would sink into a state of mere physical reaction, and thus into a state where consciousness was lacking. However, in the opposite direction the union of the four elements

and the final synthesis of the male and the female essentials are products of the Art, and therefore of a conscious effort. The result of this conscious effort the alchemists regarded as a true knowledge of the self, which was necessary for the making of the Lapis along with the knowledge of God. This cognitio sui ipsius also means a knowledge of the soul—as is suggested already in the tract by the Alexandrian alchemist Krates—for only this special knowledge enables the alchemist to understand the many attributes which the "philosophers" have given to the arcane substance. Therefore it is not surprising if the alchemists looked upon the process of their experiments not only as a physical series of changes but also as a synthesis of the soul, as a state of extended consciousness which can cause the mysterious "coniunctio" of substances as much as can the physical manipulation of the athanor and the retorts.

The coniunctio usually cannot take place unless there is present a certain medium, in which, or by means of which, the process of union can be effected. "Non fieri transitum nisi per medium", and "Mercurius est medium coniugendi" are two old alchemical maxims which attempt to explain the coniunctio. Lorenzo Ventura, a 16th century alchemical writer, describes the "Mercurius" as a mediator (Ventura also describes it as being the "anima", a spirit-substance), between body and spirit; Ripley attributes the same mediative faculty to the "Leo viridis", a common synonym for mercury. This mercury is of a "spiritual nature" and is a kind of life-force that can produce the proper union between the male and the female; it is, following the usual alchemical multiplication of attributes, the "materia seminalis" of both the male and the female "mercuries" which are joined together in and by means of the "mercurius menstrualis" (also called the "aqua" in certain texts), that intangible substance without which the operation resulting in the Lapis is impossible. Dorneus, a follower of Paracelsus, gives the philosophical explanation of this alchemical process: in the beginning God created one world; He divided this into two parts, heaven and earth. But in these two parts is hidden a third part which has the quality of a mediator, it is the original whole which exists also in both the other parts. These cannot exist without the third part, neither can this exist without the other two. The third part is the original totality of the world but the division into two parts was necessary in order to transfer the "one" world from a condition of potentiality into the state of reality. This consists of an infinite number of "things", and as "one" is not yet a number, the first number is "two" with which multiplicity begins, that is, reality begins.

Professor Jung considers this passage from Dorneus to be of great significance for the understanding of the mysterium coniunctionis of the alchemists. It concerns the restoration of the primal divine state of the world and of the divine unconscious, and at the same time there is an anticipation of that "tertium quid" which Professor Jung defines as a synchronism of incidents outside the sequence of cause and effect. What is meant here is the manifestation of what is at present called parapsychology. The unknown factors in the alchemical operations are entirely "parapsychological", and here lies the mystery, of which the key has not as yet been revealed, except to the "chosen few". It is of outstanding importance that Professor Jung, a scholar of a scientific bent of mind, admits that this third factor is the hidden PRIME MOVER of the alchemical operation. The alchemical texts in the Tibetan Tanjur, for instance, describe in greater detail than do our Western alchemical authors, and without reservations, the method by which this third factor can be isolated

from the other two and can be manipulated with increasing effect, of which the "Stone" is only the first result. The same is true of the texts in the Taoist Canon. Perhaps it will soon be possible for Western scholars to write intelligent commentaries of what have hitherto been unintelligible alchemical absurdities. A definite beginning has been made by Professor Jung.

There are three stages of the coniunctio and these are clearly described by Dorneus. The first is the "unio mentalis", the real purpose of the "meditativa philosophia", which consists of a union of spirit ("spiritus" in alchemical terminology), and soul (anima); this union can subdue the body. The second stage is the union of the "unio mentalis" with the body. The final stage can only be reached by the union of spirit-soul-body with the "unus mundas" of the beginning of the world, the divine origin of the whole scheme of the cosmos. Professor Jung says that this third stage remained a "spiritual anticipation" for the alchemists; Dorneus himself does not admit that he or any other adept had been able to complete the final stage. His Eastern counterpart, the Yogi, does however admit having attained this last stage, and his description of this final union has no counterpart among the alchemical texts of the West.

Even so, we have in this work by Professor Jung for the first time a detailed exposition of the central problem of alchemy, the mystery of conjunction. Critics will say that this is only one aspect of the subject, that alchemy is really a science based on an old metallurgic tradition which included a knowledge of chemistry and a complex system of the manipulation of heat. That this is not so anyone can find out for himself who takes the trouble to read nothing more than the titles of the many alchemical works and studies the two hundred symbolical engravings, which are an integral part of the alchemical literature of the West. Alchemy in the West, as far as it goes, seems to be a reflection of the two highly intricate systems of meditation of the East, Taoism and Yoga, with perhaps a greater emphasis on metallurgy and chemistry because of the scientific bent of mind of the West. The alchemists of the West did not have at their disposal a language with all the subtleties of an old tradition behind it, and it is this factor which largely accounts for the irritating obscurity of most of the texts. Alchemy did not develop in Europe, it came all at once; hence the difficulties of expression and description. Professor Jung's work goes a long way towards elucidating the fundamental problem of alchemy and bringing it into daylight. G. H.

Alchemy. By E. J. Holmyard. Pp. 281. 10 figs. and 36 plates. Penguin Books, 1957.

Dr. Holmyard has written a history of alchemy which will undoubtedly remain a standard work for many years to come. It is impossible to understand the meaning of alchemy without a conception of its Oriental background, of which European alchemy is only a part. It is, therefore, particularly appropriate that the present book has been written by one who combines the dual qualities of an accomplished Oriental scholar, and a humanistic scholarship as a historian of science. Perhaps a second edition of this book could include some mention of Indian alchemy, as well as a chapter on European alchemy in the 18th century—that curious phenomenon which played such a large, though hidden, part in the development of modern science.

In the important introduction (chapter 1), we have a clear exposition of the part played by Aristotelian ideas in the formation of alchemical theory. This is a fact often overlooked by other historians of alchemy, but it does not help us in filling the gaps in our scanty knowledge of Greek alchemy (chapter 2), wherein Dr. Holmyard rightly stresses the importance of the works by Bolos Democritos as leading up to Zosimos, and the writers mentioned in the Byzantine MS. in Venice. It is in Islamic alchemy that we have a most remarkable afterglow of what were once the scientific theories of late Hellenistic times. This chapter (chapter 5), gives us the best conspectus that we have, based on Dr. Holmyard's own researches, as well as on the fundamental works by Kraus and Stapleton.

It must never be forgotten that the immense prestige which alchemy enjoyed within the Islamic consensus, especially at the time of the Fatimite caliphate when relations with Europe were close, so impressed the starved European mind at that time, that alchemical ideas became, to use Dr Jung's terminology, almost "archetypal" in their persistence. The Fatimite caliph himself was supposed to have been "initiated" into the mysteries of alchemy because the Fatimite caliphs attempted to set up a rival heretical religious system based on their particular interpretation of the more esoteric aspects of late Hellenistic science. What is termed "alchemy" by the Europeans is really only a part of this Islamic "heresy", and this has resulted in a fundamental misunderstanding on the part of very many authors and students of alchemical texts as to what alchemy, as transmitted to us by the Arabs, really intends to convey. It is all there, in the works of the Arabic authors, the technical and personal terms, the adept, the elixir, the athanor, the magical transformations, and so on; all these concepts were completely alien to the European mind, and very often in direct opposition to Christian ideas. Hence the confusion and perpetual obscurity of the texts, the absolute necessity for oral instruction as transmitted by Arab teachers, and the necessity for a correct understanding of what the Arabic originals of our texts mean.

Dr. Holmyard emphasizes the great importance of Jabir ibn Hayyan, a careful study of whose works will throw an entirely new light on the whole problem of alchemy; and he discusses Professor Plessner's important discoveries with reference to the *Turba*.

There is a most interesting chapter on alchemy in Spain, under the Arabs, for it was from Spain at this time (the 10th century) that learning began to influence the West, as can be been in the poem of the nun Hrosvita, written in honour of Cordoba, "The Light of the World". Dr. Holmyard refers to the problem of the authorship of *Picatrix*, a magico-astrological work that enjoyed very great influence among European students of the hidden arts; he mentions the important alchemical work, *The Sage's Step*, by the Arabic author Maslama ibn Ahmad; and he refers to Muhammad ibn Umail, some of whose works were translated into Latin in the Middle Ages; and among other writers, to Aidamur-al-Jildaki, whose travels in search of fellow-alchemists are interesting reading.

We now come in chapter 6 to the transmission of alchemy from Islam to Western Europe. There are famous names: Robert of Chester, Gerard of Cremona, Hermann the Dalmatian, all of them great translators; and Adelard of Bath, that most gifted scholar fated to be misunderstood in his own country, followed by Roger Bacon and Albertus, both of whom reflected much more than is supposed the Arab way of thinking. There are interesting chapters on

the Latin *Geber*, and on that controversial book *The Pearl of Great Price*; and on the little-known alchemist John Dastin.

A whole chapter (chapter 8), is devoted to Paracelsus, followed by an important chapter on English alchemists, and supplemented by a chapter (chapter 10) on Scottish alchemists. In both these chapters, written in a masterly and concise fashion, there is much material put together in historical sequence for the first time: Chaucer, Ripley, Norton, and Charnock are great names among the Englishmen, whereas in Scotland we have Michael the Scot, King James IV, and Alexander Seton. In chapter 11 the two French alchemists Nicholas Flamel and Denis Zachaire are discussed; the life-story of the latter is the best authentic document we have that gives us a picture of the lives of alchemists in France in the 16th century.

Dr. Holmyard ends his book with a chapter on Helvetius and his account of a reputed transmutation: this is followed by the tragic story of James Price, and an episode in the life of the credulous and misguided German theologian Johann Semler.

There is an interesting chapter (chapter 7) on "Signs, Symbols, and Secret Terms", where the author emphasizes the subjective origin of many, if not most of these symbolical phrases, drawings, and pictures. Perhaps the common denominator here is a similar basic reaction of the human thought-mechanism to certain facts and phases of the Great Work, on the part of the alchemist, which he feels he must conceal at all costs; or perhaps he is inarticulate and alchemy is an eternal anticipation.

Chinese alchemy is discussed in chapter 3. This alchemy, where the emphasis is on the "Elixir of Long Life", and on the "Pill of Longevity", will become increasingly important to scholars. There is no doubt but that the idea of alchemy contains a much greater secret than that of the transmutation of metals; and that is the use of the *Lapis* for the purpose of not only "long life", as we translate the Chinese texts, but for a complete "translation" of the body. The careful reader will soon discover this indication even in translations of the Chinese alchemical texts; and curiously enough, there are a certain number of European texts, especially those of the 18th century, that in a guarded way emphasize this fact in opposition to the use of the *Lapis*, or the "white or red powder" for the purpose of healing the sick, or other charitable intentions.

The plates of Dr. Holmyard's book are chosen with discrimination; the drawings are excellent, and there is a useful glossary followed by two indexes.

G. H.

[**Barrett (Francis)**]: The Lives of Alchemystical Philosophers; with a Critical Catalogue of Books in Occult Chemistry, and a Selection of the Most Celebrated Treatises on the Theory and Practice of the Hermetic Art. Pp. 382. 1 plate. London: John M. Watkins, 1955. (Reprinted edition limited to 250 numbered copies.) Price £3 3s.

This book was first published in 1815, and some copies were issued with two variant title-pages and imprints dated 1814, and 1815, respectively. The authorship is anonymous, but cataloguers have ascribed it to Francis Barrett, who, in 1801, published *The Magus*, which was a compendium of the occult lore of his time. The original edition of *The Lives of Alchemystical Philosophers* has been a bibliographical rarity for at least seventy years, and, even from this aspect, the present facsimile reprint may be welcomed. But there are also

certain features of the book that were not included by A. E. Waite in his revised and remodelled edition of 1888, which was based upon Barrett's *Lives*, and had the same title. These particular features refer to a series of extracts and translations from various alchemical treatises, and they comprise the main text of the book under review. It has been possible to examine many of the original printed texts, and to compare them with Barrett's versions. With only a few exceptions, most of this material was found to have been taken verbatim from English translations of alchemical texts, such as are contained in Salmon's *Medicina Practica*, 1692; Sendivogius, *A New Light of Alchymie*, 1650; *Philaletha, Secrets Reveal'd*, 1669; Ashmole's *Theatrum Chemicum Britannicum*, 1652; and Basil Valentine's *Triumphant Chariot of Antimony*, 1678. As all of these reprinted extracts have been taken from texts which, by reason of their rarity, are not easily accessible to the student, it is unfortunate that Barrett did not supply detailed references to the original sources of his information.

The section on alchemical treatises commences on page 122 and ends on page 384. It contains extracts from the works of Freher [a disciple of Jacob Böhme], Artephius, *The Ancient War of the Knights* [from the English edition of 1723], Philaletha, Seton, Weidenfeld, Welling, Ripley, Pontanus, Valentinus, Urbigerus, Flamel, Lullius, D'Espagnet, Böhme, Penotus, Christophorus Parisiensis, Arislaeus, Roger Bacon, Synesius, Hermes, Anonymus von Schwartzfus, and other alchemical authors. Barrett does not refer to Anonymus von Schwartzfus, but the tract entitled *Sanguis Naturae* is taken from an English edition of 1696 which ascribes the authorship to this unknown, and probably fictitious, personage. Incidentally, this was one of the alchemical books studied by Newton, and Duveen has recorded a copy which contained the following note in Newton's handwriting: "Sanguinis Naturae, at Sowles a Quaker Widdow in White Hart Court at ye upper end of Lombard Street". Despite the unscholarly presentation of these tracts, they are not without a certain interest and use in the study of alchemical literature.

The *Lives* are contained in the first portion of the book, and in some instances references are cited. In general, the biographies are somewhat transiently handled; and although Waite revised and remodelled the text for his own edition, it is doubtful if it deserved the trouble he bestowed on it. As regards the *Critical Catalogue of Books* mentioned on the title-page, 751 alchemical books are listed on pages 95–112, but the description of this list as being "critical" is entirely a misnomer. Nevertheless, the catalogue is much easier to consult than in Waite's edition, which did, however, include some 72 additional titles.

Notwithstanding these limitations, Barrett's *Lives of Alchemystical Philosophers* contains much interesting information not readily obtainable elsewhere, and its reappearance in facsimile can be commended. D. G.

La Alquimia. By Professor Josué Gollan (h). Librería Y Editorial Castellví S.A. Sante Fe, Argentina. 1956. Pp. 361. Many drawings and diagrams and reproductions of symbolical engravings.

This book is written by a scholar and a scientist whose aim is given in the prologue: Este libro, destinado a divulgar la historia de la alquimia en sus diversos aspectos . . . . The author rarely expresses an opinion himself, he is content to quote from texts—there are indeed copious quotations from innumerable writers—and from the recognized authorities of the 19th and 20th centuries who have written on all aspects of alchemy, as well as from writers

whose works unfortunately have no value whatsoever. This latter fact vitiates the otherwise sound scholarship of Professor Gollan; there is also a tendency to categorize facts and pigeon-hole them, and to solve all abstruse problems in one volume, a tendency noticeably on the increase across the Atlantic in recent years.

Book I is entitled "panorama Alquimico". Here we are given a very comprehensive review of alchemists of all countries and what they tried to do, the origin of the word "alchemy", a chapter on what the Philosopher's Stone really purports to be (there is no reliable evidence of the fact that Rudolph II effected a transmutation as mentioned in this chapter), and the history of the transmission and evolution of alchemical ideas. In the interesting table at the end of this chapter, mention might have been made of Indian alchemy and its probable origin in the Mhenjo Daro civilization.

Book II deals with the literature of alchemy. A good résumé is given of the earliest texts, including a detailed reference to Professor Stapleton's important article in this journal on the origins of alchemy. There are many quotations from European writers on alchemy, many of them taken from Professor Read's *Prelude to Chemistry*. In Book III, one of the most interesting sections of the book, we are given an historical analysis of the theories of alchemy, of the so-called process of transmutation and the "technical" aspect of its manipulation, and a very comprehensive chapter on alchemical symbolism. Professor Gollan, however, uses the term "cabalistic symbolism" when describing a well-known alchemical symbolical engraving (see p. 189) which is *not* one of the series of the "Twelve Keys" of Basil Valentine; we should like to know exactly what is meant by the word "cabalistic". In Book IV we are given an historical survey of the influences that gave rise to alchemical theories. The first chapter, which takes us from Paleolithic man (400,000 B.C.) to Napoleon, is a rather superficial, but learned treatise on the history of alchemical ideas, followed by a detailed historical table of eight pages. Then there are chapters on the technique of alchemy, on magic, on the cabala (we should like to refer the author to Scholem's special articles on "cabala" and alchemy), and on numerology. This last chapter is important as it describes the Arabic theory of balances and includes Professor Stapleton's paragraph on magic squares and the gnomon. Chapters follow on astrology; on Greek philosophy and its relation to alchemy, with another detailed table, and finally, there is a chapter on the religious ideas of late Hellenistic times. Here we have references to primitive Christianity, to the Gnostics, and to Philo, and their probable influence in the formulation of alchemical theories. The last book, "La Evolución", attempts to relate alchemical ideas to modern scientific theory; and in the epilogue we have a graceful summing up of the whole subject: the ideas as put forth by the alchemists are still with us and are the seeds of further scientific progress. G. H.

Frère Basil Valentin. Les Douze Clefs de la Philosophie. Traduction, Introduction, Notes et Explication des Images par Eugene Canseliet. Pp. 264. 14 plates. Edition limited to 1,000 copies. Les Editions de Minuit, 1956. 2500 Frs.

In his introduction M. Canseliet gives us the results of his wide knowledge of the subject; his allusions to different authors, his interpretations of words and phrases and his acquaintance with the imagery of alchemy constitute a literary

tour de force of no mean order. Everything that can be said about Basil Valentine, every reference by an author even remote from the alchemical tradition has been collected and interpreted. In a sense the method of M. Canseliet can be said to derive from works of former centuries, such as the *Arcana Arcanissima* of Michael Maier or Dom Pernety's *Dictionary*, but here we have this method perfected with all the resources of modern scholarship and bibliographical research. In addition to his giving us practically all information that is known about the author of the *Twelve Keys*, M. Canseliet's preface shows once again how European thought in the past has been permeated with alchemical allegories, almost as if these allegories—in the Jungian sense?—were a necessary compensation for a dangerous scientific rationalism always lurking in the depths.

The translation of the text of the *Twelve Keys* supplants earlier French translations, such as the one by the brothers Perier, and the well-known 17th century work by Pierre Moët. Great care has been taken always to use the best Latin version and to give exact meaning to many obscure German phrases that are found in practically all the German works. M. Canseliet's interpretation of the twelve symbolical engravings is most interesting and is based on his profound knowledge of the mediaeval tradition of alchemy. G. H.

Nouvelle Assemblée des Philosophes Chymiques. By CLAUDE D'YGÉ. Pp. 233; index. Paris: Dervy Livres, 1954.

THIS book is a collection of texts taken for the most part from little-known works by French authors. In the preface, written by M. Canseliet with his usual brilliance, attention is drawn to the fact that these texts have been chosen with great care, and each of them throw light on the "principes de l'alchimie" as well as on the "premier agent" of the Great Work.

There are some rare works, the authors of which are mentioned neither by Schmieder or Ferguson, such as Saunier de Beaumont and Pierre Ange Manzolli. Chapters are given from the two works by the Abbé Albert Belin[1]; from the work by the 18th century alchemist Cailleau[2]; from the interesting work by Tacxsi[3] and from the very rare anonymous work *De la Transformation Metalliqué*, Paris, 1561. The whole text, without the preface, is given of Montluisant's interpretation of the sculptured figures over the main portal of Notre Dame and there is a long quotation from the work of Nicolas Valois, an author whose manuscripts still await publication. He, together with Vicot and Grosparmy, whose works are also still unpublished, all three from Normandy, are among the most famous alchemists of France[4].

French alchemical writers approach our subject very often from a different point of view. It is necessary that this point of view be taken into consideration when considering European alchemy as a whole. French alchemical writers make much greater use of symbols which we should term "mediæval and Christian"; the ancient Arabic pattern of alchemical concepts, both exoteric and esoteric, has not the same importance in mediæval France as it has, for

[1] Dom Albert Belin: *Les Aventures du Philosophe inconnu, Paris, 1646; Apologie du Grand-Oeuvre ou Elixir des Philosophes*, Paris, 1659.

[2] Cailleau: *Clef du Grand Oeuvre, ou Lettres du Sancelrien Tourangeau*, Paris, 1777.

[3] Tacxsi: *La Suisse Catholique deux fois, ou Doctrine Philosophique*, Paris, 1814.

[4] See the important work by Paul Kuntze: *Le Grand Olympe*, Halle, 1912.

instance, in contemporary England or Germany. Arabic ideas have been adapted to the European way of thinking to a great extent by the "School of Lull" and have been largely followed by those alchemists whose works are described in our histories and bibliographies and are published in collections of texts such as the *Theatrum Chemicum*. French alchemical symbolism is only a part of the Catholic symbolism of mediæval France, the most perfect expression of which we find in the architecture and the ancient tapestries that used to hang in the cathedrals. There is a further problem to be considered. Many of the later French alchemical writers, like Cyrano de Bergerac, or Grosparmy in his *Grande Olympe*, the work by which he is known, are very subjective in their interpretation of the alchemical process and often most obscure; Ripley and Philaletha, on the other hand, to take two examples nearer home, are always logical, and with a little study their seeming obscurity can be penetrated, and we know what they wish to tell us. The "French approach" can only be appreciated if we accept it in terms of the symbolism of the mediæval Christian church, although there is present an additional element, which derives from Persia: the legend of the Grail. Without an appreciation of the French alchemical tradition we should be unable to understand those marvellous creations of European phantasy that hover on the periphery of esoteric alchemy, the achievements of the Knights of the Grail and the Golden Rose of Syria, given "à la plus docte dame en Gay Saber".

M. d'Ygé has brought together in one volume a large number of texts taken from the works of French alchemical writers. We are now better able to understand the particular approach to our subject by the French alchemists; and we can admire their profound knowledge of the symbolism of the Middle Ages which they use as the means to solve the alchemical enigma. G. H.

Torbern Bergman. Om Luftsyra; Om Mineralvatten. Pp. 127. Stockholm: Almqvist & Wiksell, 1956. Pris. kr.15. (An English edition, translated by Sven M. Jonsson, is available at the same price.)

Bergman's dissertations on the "Aerial Acid"; and on "Bitter, Selzer, Spa and Pyrmont Waters and their Synthetical Preparation" are reproduced here, in facsimile, from the original publications of 1773–5 in the *Transactions* of the Royal Academy of Science, Stockholm.

The methods which Bergman developed during these researches on carbon dioxide and mineral waters, enable the student of historical chemistry to appreciate those analytical characteristics which distinguished him from many of his more empirically-minded contemporaries. Priestley, for example, considered that pure water saturated with "fixed air" embodied all the medicinal virtues of genuine Pyrmont water; and although he did not exclude the possible advantage which might result from the substitution of an ordinary chalybeate water in his process, the problem was not further examined.

Bergman, on the other hand, realized the importance of analysis in experiments of this nature. He realized, also, the significance of detecting and controlling the acidity factor in mineral water formulations; and he correctly deduced that water analyses did not necessarily indicate the actual chemical combinations in which the mineral constituents normally existed in solution.

The book, under review, is well-produced and illustrated. It includes references to other Bergman literature on these subjects; and a table showing modern equivalents of the Swedish weights and measures used by Bergman.

Finally, Dr. Uno Boklund contributes an interesting essay on "Torbern Bergman as a Pioneer in the Domain of Mineral Waters", in which is illustrated a page from Bergman's laboratory notes of 1772.

These reprints are due to the Sveriges Vattenfabrikanters Riksförbund. They form part of a Bergman series which includes *A Bibliography of Torbern Bergman's Works*, compiled by Birgitta Moström, Stockholm, 1956; and *The Foreign Correspondence of Torbern Bergman*, Upsala, 1956, published by the Lärdomshistoriska Samfundet.

D. G.